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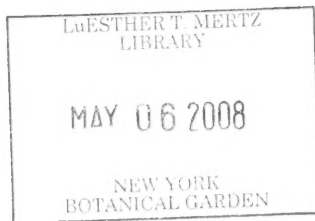
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INFRASPECIFIC ADJUSTMENTS IN *JUNIPERUS DEPPEANA* (*CUPRESSACEAE*)

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ABSTRACT

Recent DNA sequencing data have shown that *J. gamboana* is well supported in a clade that includes other varieties of *J. deppeana*. *Juniperus gamboana* has checkered bark as is common in *J. deppeana*, and is treated herein as a variety of the latter, *J. deppeana* var. *gamboana* (Mart.) R. P. Adams, **comb. nov.** Examination of *J. deppeana* var. *zacatecensis* shows that it only differs from *J. d.* var. *deppeana* in having larger, more glaucous female cones, so it is reduced to the forma: *J. deppeana* f. *zacatecensis* (Mart.) R. P. Adams, **stat. & comb. nov.** A key and revised distribution map of *J. deppeana* is presented.

KEY WORDS: *Juniperus deppeana* varieties, *J. gamboana*, *J. deppeana* var. *gamboana*, *J. deppeana* f. *zacatecensis*, *Cupressaceae*, taxonomy.

Juniperus deppeana Steudel and *J. gamboana* Martinez are species whose stem bark commonly exfoliate in quadrangular plates (Zanoni and Adams, 1976, 1979). These two species are part of the serrate leaf margined *Juniperus* species of the western hemisphere (Adams, 2004). The first systematic treatment of these junipers was by Martinez (1963).

DNA sequencing of nrDNA (ITS) and trnC-trnD (Schwarzbach, et al. 2007) has revealed that *J. deppeana* and its varieties form a clade that includes *J. gamboana* (Fig. 1). In addition, *J. deppeana* var. *deppeana*, *J. d.* var. *patoniana* and *J. d.* var. *robusta* are each distinct clades (Fig. 1). The bark exfoliation patterns in *Juniperus deppeana* and *J. gamboana* are shown in figure 2. *Juniperus gamboana* differs from *J. deppeana* by

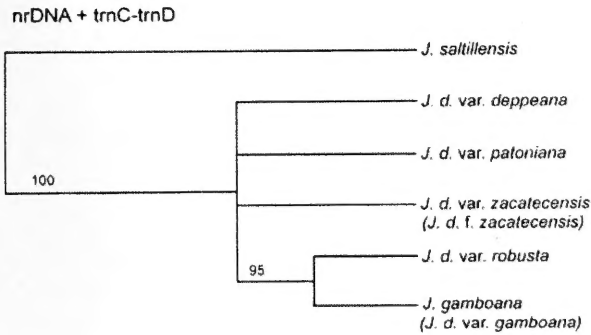
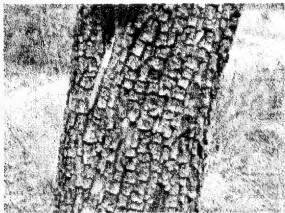


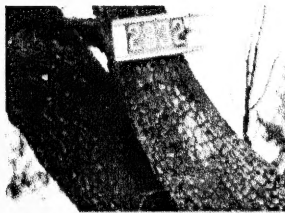
Figure 1. Phylogenetic tree derived from nrDNA + trnC-D sequence data (adapted from Schwarzbach et al., 2007). Notice the support (95%) for the clade of *J. d. var. robusta* and *J. gamboana*. The other varieties of *J. deppeana* are resolved as distinct clades.



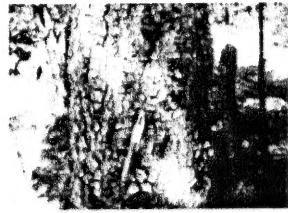
J. d. var. deppeana



J. d. var. patoniana



J. d. var. robusta



J. d. var. gamboana

Figure 2. Comparison of bark exfoliation patterns. Note the checked bark of *J. d. var. gamboana* and the phylogenetically closely related *J. d. var. robusta*. (The photos of *J. d. var. patoniana* and *J. d. var. robusta* are from T. A. Zanoni).

having one (sometimes 2) seed per cone versus (1) 2 - 7 seeds per cone. Considering their similar morphology and the new DNA sequence data, it seems appropriate to treat *J. gamboana* as a variety of *J. deppeana*:

***Juniperus deppeana* Steudel var. *gamboana* (Martinez) R. P. Adams, comb. nov.**

BASIONYM: *Juniperus gamboana* Martinez., Anales Inst. Biol. Univ. Nac. Mexico 15(1): 7 (1944).

Cedro, cipres, cipres comun, bac'il nuhkupat (Tzeltal at Tenejapa, Chiapas), K'uk'',ton, nukul pat (Tzotzil at Zinacantan, Chiapas), gamboa juniper. Type: Mexico: Chiapas: near Teopisca, Martinez 6701 (Holotype: MEXU!)

Distribution: on limestone soils in pine-oak and pine-oak-juniper forest in the mountains at 1670-2200 m in Chiapas, Mexico; on limestone hillsides near San Miguel Acatan at 1920-2140 m in the Sierra de los Cuchumantes of Depto. Huehuetenango, Guatemala (see Fig. 3).

Because *J. deppeana* var. *zacatecensis* differs from *J. d.* var. *deppeana* only in having larger, more glaucous female cones, such variation appears to fit more closely that of a form:

***Juniperus deppeana* Steudel f. *zacatecensis* (Martinez) R. P. Adams, stat. & comb. nov.**

BASIONYM: *Juniperus deppeana* var. *zacatecensis* Martinez, Anales Inst. Biol. Univ. Nac. Mexico 17(1): 57 (1946).

Zacatecas juniper, cedros. Type: Mexico: Zacatecas: 10 km. W. of Sombrette. Martinez A503 (Holotype: MEXU!).

Juniperus zacatecensis (Martinez) Gaussen. Trav. Lab. Forest. Toulouse Tome II. Sec. I Vol. 1. partie II 2. fasc. 10. 151. 1968

The forma differs from *J. d.* var. *deppeana* in having larger (10-20 mm diam.) female cones with a heavy bloom (waxy coating).

Distribution: In oak-pine-juniper and pinyon-juniper woodlands and on grasslands on hills at 1980- 2470 m elevation, Zacatecas and adjacent Durango and Aguascalientes, Mexico (see Fig. 3).

Juniperus deppeana and its varieties form a discontinuous ring in the mountains above 2000 m (occasionally down to 1500 m) around the Chihuahuan desert in the southwestern US and Mexico, thence at 1600 - 2200 m in the mountains in the very southern-most part of Mexico and northern Guatemala (Fig. 3). Wells (1966), using data from rat middens



Figure 3. Distribution map of *J. deppeana*. The population of *J. d. var. patoniana* (P) in n. Sonora, Mexico has previously been called *J. d. f. sperryi*, but appears more likely to be *J. d. var. patoniana*.

from the Big Bend Texas region, concluded that during the Wisconsin (70,000 - 13,000 ybp) life zones descended about 800 m enabling the formation of pinyon-juniper in the present Chihuahuan desert between the Big Bend Region of Trans-Pecos, Texas and the city of Del Rio. Even if the effects of glaciation were mediated southward into Mexico so that life zones descended only a few hundred meters in Hidalgo, it appears that all of the now disjunct populations (varieties) of *J. deppeana* were connected

in a continuous ring of distribution around the Chihuahuan desert (perhaps with islands of *J. deppeana* within the ring). The recently described *J. d. f. elongata* R. P. Adams (Adams & Nguyen, 2005) grows as scattered trees in the Davis Mountains of Trans-Pecos, Texas.

Key to *Juniperus deppeana* varieties:

- 1a. Terminal whips long (15 - 30 cm) and pendulous, all (or nearly all) leaves on adult plants juvenile (decurent, or whip type)
.....var. *deppeana* f. *elongata*
- 1b. Terminal whips short (5 - 10 cm) and not pendulous, all leaves on adult plants scale-like (except on new growth where whip leaves occur)
 - 2a. Seed cones small (5-8 mm diam.), with soft pulp and 1(2) seeds, reddish brown with a light bloom, Chiapas, Mexico and adjacent Guatemala.....var. *gamboana*
 - 2b. Seed cones large (8-20 mm diam.), woody and (1) 2 - 7 seeds, brown, reddish brown, or purplish with little to copious bloom, from central Mexico northward to Arizona and New Mexico in USA.
 - 3a. Stem bark longitudinally furrowed into long, interconnected strips, terminal whip branches often flaccid and pendulous.....
..... var. *deppeana* f. *sperryi*
 - 3b. Stem bark in quadrangular plates or in longitudinal strips (occasionally interconnected, if exfoliating in strips, then foliage not weeping), occasionally quadrangular plates at the trunk base, terminal whip branches ascending to erect
 - 4a. Stem bark exfoliating in longitudinal strips (occasionally interconnected) or with plates near the trunk base.....
.....var. *patoniana*
 - 4b. Stem bark exfoliating in square or oblong quadrangular plates, not in strips.
 - 5a. Trees with a strong central axis, no major side branches, crown pyramidal, and open as in *Cupressus*, often with 2 (3-4) trunks rising at (or below) ground level.....var. *robusta*
 - 5b. Trees with round crown, branching at 1-4 m to produce irregular, round crown, usually with a single trunk
 - 6a. Mature female cones larger, 10-20 mm. diam., heavy bloom (glaucous waxy coating) on cone surface causes cone to appear white; shrub/small round topped tree (to 8m)

.....var. *deppeana* f. *zacatecensis*
 6b. Mature female cones smaller, 8-15 mm diam., glaucous
 or not, if glaucous not appearing as white, small to large
 treesvar. *deppeana*

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RE-EXAMINATION OF THE TAXONOMY OF *JUNIPERUS*
FLACCIDA VAR. *MARTINEZII*, AND VAR. *POBLANA*
(*CUPRESSACEAE*)

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ABSTRACT

Recent DNA sequencing data have shown that *J. flaccida* var. *flaccida*, *J. f.* var. *martinezii* and *J. f.* var. *poblana* are polyphyletic taxa. Additional analysis using Random Amplified Polymorphic DNAs (RAPDs) analyses for *J. durangensis*, *J. flaccida* var. *flaccida*, var. *martinezii*, and var. *poblana*, *J. jaliscana*, *J. monticola* and *J. standleyi* revealed exactly the same pattern of relationships as seen with the sequence data. Specifically, that *J. flaccida* and its varieties are polyphyletic. Upon re-examination of the morphology, *J. f.* var. *martinezii* and var. *poblana* are recognized as distinct species: *J. martinezii* Perez de la Rosa and *J. poblana* (Mart.) R. P. Adams, **stat. nov.**

KEY WORDS: *Juniperus flaccida*, *J. f.* var. *martinezii*, *J. f.* var. *poblana*, *J. martinezii*, *J. poblana*, *Cupressaceae*, taxonomy, RAPDs.

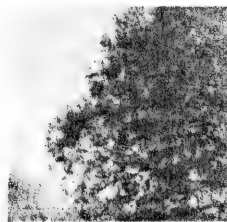
MARTINEZ

The taxonomy of *Juniperus flaccida* Schltdl. has been somewhat unsettled. Generally, flaccid (weeping) foliaged junipers in Mexico (and the Chisos Mtns., Texas) have been referred to as *J. flaccida*. The first systematic treatment of these junipers was by Martinez (1963) who recognized two varieties: *J. f.* var. *typica* and *J. f.* var. *poblana* Mart. *Juniperus f.* var. *flaccida* has large seed cones (9-20 mm), with 6-10

seeds, and pendulous (flaccid) foliage and branchlets (Fig. 1). *Juniperus f. var. poblana* also has large seed cones (9-12 mm), with 6-10 seeds, but the foliage is distichous and in vertical planes like *Thuja*, and not very flaccid (Zanoni and Adams, 1976, 1979; Adams, 2004). In fact, the earliest name for this taxon was *Cupressus thurifera* Kunth which is indicative of the planate nature of the foliage (shown in Fig. 1). Perez de la Rosa (1985) discovered a population of trees that had small seed cones (5-7 mm), with 1-2 seeds per cone and with foliage somewhat drooping but branchlets erect (Fig. 1). He described this taxon as a new species,



J. f. var. flaccida



J. f. var. martinezii



J. f. var. poblana

Figure 1. Comparison of leaf foliage among *J. f. var. flaccida*, *J. f. var. martinezii* and *J. f. var. poblana*.

J. martinezii Perez de la Rosa. Except for the seed cones, the taxon looks similar to *J. flaccida*; indeed Silba (1985) treated it as *J. flaccida* var. *martinezii* (Perez de la Rosa) Silba. Each of these varieties has leaf margins that are hyaline and nearly entire, with either a few small teeth or merely a wavy margin (Adams, 2004). However, they are considered part of the serrate leaf margined *Juniperus* species of the western hemisphere (Adams, 2004).

Adams et al. (1990) compared the leaf essential oils and found considerable differences among the *J. flaccida* varieties. However, they decided to accept *J. flaccida* var. *martinezii* until "...additional data, such as from DNA analysis, are available." (Adams et al. 1990).

Recently, DNA sequencing of nrDNA (ITS) and trnC-trnD (Schwarzbach, et al. 2007) has revealed that *J. flaccida* varieties are not monophyletic (Fig. 2). It will be noticed that *J. f. var. poblana* is not closely related to any juniper and that *Juniperus f. var. martinezii* is more closely related to *J. durangensis* than to *J. f. var. flaccida* (Fig. 2).

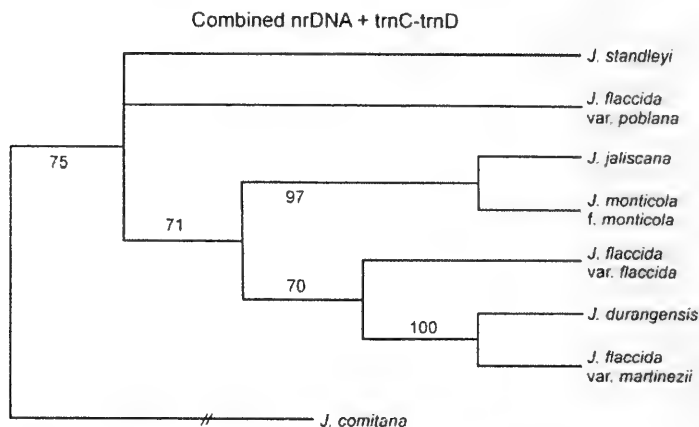


Figure 2. Partial phylogenetic tree derived from nrDNA + trnC-trnD sequence data (adapted from Schwarzbach et al., 2007). Values above branches are posterior probabilities. Note that *J. f.* var. *flaccida*, *J. f.* var. *martinezii* and *J. f.* var. *poblana* are in separate clades that are well supported.

To investigate this pattern more closely, DNA fingerprinting analyses were performed for the same taxa (Schwarzbach et al., 2007). RAPDs (Random Amplified Polymorphic DNAs) is a form of DNA fingerprinting that has been used in several *Juniperus* studies and has proved useful in systematics (Adams, 1999, 2000a-d; Adams and Demeke, 1993; Adams and Nguyen, 2005), when stringent laboratory procedures are followed (Adams, Flournoy and Pandey, 1998). In this study, we report on RAPDs analysis and combine these results with the DNA sequence data and morphology to evaluate the taxonomic status of *J. flaccida* and its varieties.

MATERIALS AND METHODS

Specimens collected: *J. comitana*, Adams 6858-62, 14 km s of Comitán, thence 14 km e on road to Montebello, Chiapas, Mexico; *J. durangensis*, Adams 6832-35, at km 152 on Mex. 40, 52 km w of El Salto, Durango, Mexico; *J. flaccida* var. *flaccida*, Adams 6892-96, 23 km

e of San Roberto Junction on Mex. 60, Nuevo Leon, Mexico; *J. flaccida* var. *martinezii*, Adams 5950-52, 8709, 40 km n of Lago de Moreno on Mex. 85 to Amarillo, thence 10 km e to La Quebrada Ranch, 21° 33.08' N, 101° 32.57' W, Jalisco, Mexico; *J. flaccida* var. *poblana*, Adams 6868-70, 62 km s of Oaxaca, Mexico on Mex. 190; *J. jaliscana*, Adams 6846-49, 19 km e of Mex. 200 on dirt road to Cuale, Jalisco, Mexico; *J. monticola* f. *monticola*, Adams 6874-78, El Chico Nat. Park, 8 km ne of Pachuca, Hidalgo, Mexico; *J. standleyi*, Adams 6852-56, 24 km nw of Huehuetango on road to San Juan Ixcay, Huehuetango, Guatemala. Voucher specimens are deposited at BAYLU.

One gram (fresh weight) of the foliage was placed in 20 g of activated silica gel and transported to the lab, thence stored at -20° C until the DNA was extracted. DNA was extracted using the Qiagen DNeasy mini kit (Qiagen Inc., Valencia, CA). The RAPD analyses follow that of Adams and Demeke (1993). Ten-mer primers were purchased from the University of British Colombia (5'-3'): 134, AAC ACA CGA G; 153, GAG TCA CGA G; 184, CAA ACG GAC C; 212, GCT GCG TGA C; 218, CTC AGC CCA G; 239, CTG AAG CGG A; 249, GCA TCT ACC G; 250, CGA CAG TCC C; 338, CTG TGG CGG T; 346, TAG GCG AAC G; 347, TTG CTT GGC G; 375, CCG GAC ACG A; 431, CTG CGG GTC A; 478, CGA GCT GGT C.

PCR stock solutions (Taq, primer, and buffer) were made in bulk so that all the PCR reaction tubes for a primer were prepared using the same bulk stock. This is a critical factor for minimizing variation in band intensities from sample to sample (see Adams, Flournoy and Pandey, 1998, for protocols to minimize PCR band variation). PCR was performed in a volume of 15 µl containing 50 mM KCl, 10 mM Tris-HCl (pH 9), 2.0 mM MgCl₂, and 0.1% Triton X-100, 0.2 mM of each dNTPs, 0.36 µM primers, 0.3 ng genomic DNA, 15 ng BSA and 0.6 unit of Taq DNA polymerase (Promega). A negative control PCR tube containing all components, but no genomic DNA, was run with each primer to check for contamination. DNA amplification was performed in an MJ Programmable Thermal Cycler (MJ Research, Inc.). Samples were run in duplicate to insure reproducibility (Adams, Flournoy and Pandey, 1998). A temperature profile was obtained for each well of the thermocycler to be sure that no variation existed among wells in the heating/ cooling block. The thermal cycle used was: 94° C (1.5 min) for initial strand separation, then 40 cycles of 40° C (2 min),

72° C (2 min), 91° C (1 min). Two additional steps were used: 40° C (2 min) and 72° C (5 min) for final extension. The temperature inside a PCR tube containing 15 µl buffer was monitored with a temperature probe, quantitated and printed for each step for each of the 40 cycles for every PCR run (Adams, Flournoy and Pandey, 1998) to insure that each cycle met temperature specifications and that each PCR run was exactly the same. Amplification products were analyzed by electrophoresis on 1.5% agarose gels, 75V, 55 min, and detected by staining with ethidium bromide. The gels were photographed over UV light using Polaroid film 667 and scanned to digital images. The digital images were size normalized in reference to pGem® DNA size markers before band scoring. Bands were scored as present (1) and absent (0). Bands that were inconsistent in replicate analyses were not scored.

Associational measures were computed using absolute character state differences (Manhattan metric), divided by the maximum observed value for that character over all taxa (= Gower metric, Gower, 1971; Adams, 1975). Principal coordinate analysis (PCO) was performed by factoring the associational matrix using the formulation of Gower (1966) and Veldman (1967). It should be noted that problems of homology of RAPD DNA bands on agarose gels can be significant (Rieseberg, 1996), but these errors can be accounted for using multivariate statistical methods (PCO) (see Adams and Rieseberg, 1998). A minimum spanning diagram was constructed by selecting the nearest neighbor for each taxon from the pair-wise similarity matrix, then connecting those nearest neighbors as nodes in a network (Adams, et al. 2003).

RESULTS AND DISCUSSION

The RAPDs data (Fig. 3) are essentially identical to the sequence data (Fig. 2). As with the sequence data (Fig. 2), the RAPDs show (Fig. 3) the *J. flaccida* varieties do not form a monophyletic group. *Juniperus flaccida* var. *poblana* is very distinct. *Juniperus flaccida* var. *flaccida* and *J. f.* var. *martinezii* are in the same group that includes *J. durangensis* (Fig. 3). *Juniperus durangensis* does share some seed cone characteristics with *J. f.* var. *martinezii* (Table 1). However, *J. durangensis* and *J. f.* var. *martinezii* are quite distinct in their morphology.

Zanoni and Adams (1976) have shown that *J. f.* var. *flaccida* and *J. f.* var. *poblana* are about as different in morphology as other serrate

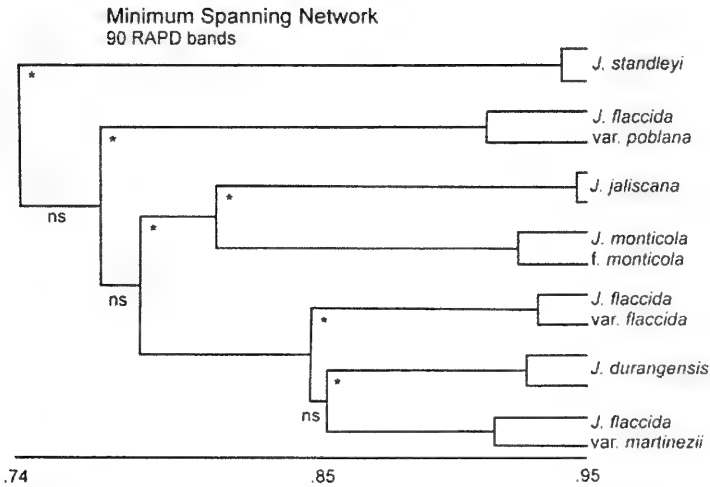


Figure 3. Minimum spanning network based on 90 RAPD bands.
* = significant at $p = 0.05$. ns = not significant.

	<i>flaccida</i>	<i>poblana</i>	<i>martinezii</i>	<i>durangensis</i>
seeds/cone	(4-)6-10(-13)	(4-)6-10(-13)	1-2(-3)	1-3(-4)
cone size	9-20 mm	9-15 mm	(5-)6(-9) mm	6-7 mm
cone color	tan to brownish/ purple	bluish-brown	brown	bluish-red
cone shape	spherical	spherical	ovoid, gibbous	ovoid, gibbous
terminal branch tips	hanging, but straight	hanging, but, straight	erect and straight	curved on tips
branching	radially	planate	radially	radially

leafed juniper species in Mexico. Essential leaf oil analysis (Zanoni and Adams, 1976) indicated that the oil of *J. f. var. poblana* was a little more similar to oil of *J. comitana* than to *J. f. var. flaccida* leaf oil. Of course, *J. f. var. martinezii* had not been discovered at that time (1976). Later, Adams et al. (1990) reported on the volatile leaf oils of *J. flaccida* var. *flaccida*, *J. f. var. martinezii* and *J. f. var. poblana* and found several components that differed between the taxa: α -pinene, sabinene, α -phellandrene, β -phellandrene, terpinolene, linalool, camphor (11.4% in var. *martinezii* vs. 0.5 and trace in vars. *flaccida* and *poblana*), terpinen-4-ol, bornyl acetate, γ -cadinene, manoyl oxide, and kaur-16-ene.

In summary, although *J. f. var. flaccida*, *J. f. var. martinezii* and *J. f. var. poblana* were never considered closely related, because they were not similar to any other Mexican taxa, they have been lumped under *J. flaccida* (Zanoni and Adams, 1979; Adams, 2004). With the new insight from both DNA sequence and RAPDs data, the following nomenclature is proposed:

***Juniperus poblana* (Martinez) R. P. Adams, stat. nov.,**

Basionym: *Juniperus flaccida* var. *poblana* Martinez., Anales Inst. Biol. Univ. Nac. Mexico 17:31 (1946).

Cedro, poblana juniper, Pueblo juniper. Type: Mexico: Puebla: Amozoc at 2300 m, *Martinez 507* (Holotype: MEXU!)

Distribution: from Jalisco, east to Oaxaca, Mexico. See map, p. 112, Adams (2004).

Both the DNA sequence and RAPD data support the morphology for the recognition of *Juniperus f. var. martinezii* at the specific rank (*Juniperus martinezii* Perez de la Rosa). Additional research (in progress) on geographic variation in *J. flaccida* (sensu stricto) is needed to understand the variation within this species.

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KEYS TO THE FLORA OF FLORIDA -- 14, *VIOLA* (VIOLACEAE)

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ABSTRACT

Viola (Violaceae) is represented in Florida by 13 species, two of which are introduced. *Viola palmata* is treated as formed of two varieties, with var. **esculenta** recognized as a new name, and with validity of the epithet explored. Specific distinction, both in morphology and range, is drawn for *Viola sororia*, *Viola affinis*, and *Viola floridana*. Applicability of *Viola kitaibeliana* to the Florida flora is examined. Seven species reported for Florida are here excluded. An amplified key is given to the Florida taxa.

KEY WORDS: *Viola*, Violaceae, Florida flora.

The genus *Viola* (Violaceae) has long charmed otherwise level-headed botanists into lifetimes of rapt devotion. Most notably, Ezra Brainerd (*Violets of North America*. 1921) spent decades in study of the genus (his passion extending even to the naming of his daughter, Viola Brainerd Baird, a violet author in her own right). Decades later, the equally zealous Norman H. Russell took up the torch, with his study of the white-flowered species (*Amer. Midl. Nat.* 54:481-494. 1955) and an overview of the genus in North America (*Sida* 2:1-113. 1965). Russell's commitment resurfaced with co-authorship of a survey of the southeastern species (L. E. McKinney & N. H. Russell, *Castanea* 67:369-379. 2002).

These major efforts have been supplemented by a plethora of briefer, often regional studies (as noted by McKinney & Russell). The "stemless blues" have been addressed by H. E. Ballard, though his major works remain unpublished. Arthur Cronquist completed, but

never published, a full treatment of the southeastern species; his 1980 manuscript, generously circulated, has been of aid to many others. Landon E. McKinney (Sida, Bot. Misc. 7:1-60. 1992) revised the "stemless blues" for North America. N. L. Gil-Ad, in his thesis (Michigan. 1995) and later partial publication (Brittonia 50:91-121. 1998), re-examined and further elucidated the same complex.

Other studies were more limited in range but more understanding of local variations. Two brief but informative articles by W. A. Murrill (Ecology 21:512-513. 1940a; J. Elisha Mitchell Sci. Soc. 56:367-370. 1940b), largely overlooked by violet scholars, examined the 10 species then recognized for northeast Florida (Alachua County) for distinguishing morphology, habitat, and soil pH. Two "guides" to the flora of the Florida panhandle (A. F. Clewell, Guide to the Vasc. Plants of the Florida Panhandle. 1985) and the entire state (R. P. Wunderlin, Guide to the Vasc. Plants of Florida. 1998), though useful, are too concise to permit clear understanding of taxonomic judgments.

Viola palmata is here recognized as two rather sharply distinguished populations, which are given varietal status. *Viola palmata* (s.s.), described by Linnaeus (1753) from a Virginia type, was understood by Brainerd (1921), Small (1933), Russell (1965), and other authors to be a northern species, unknown in Florida. [Small's (1933) extension of the range to Florida was in error.] But according to McKinney (1992), the name is correctly typified by what has been called *V. triloba* Schweinitz (1822), a familiar southeastern species, thus (once again) bringing the name *V. palmata* into Florida usage. [McKinney then treated the northern species as *V. subsinuata* Greene.]

Expanding on the judgment of earlier authors, Murrill (1940a, 1940b) separated *Viola palmata* (his *V. triloba*) from *V. esculenta* by both habitat and soil pH. This distinction seems justified. In the field one can predict that the lightly pubescent thin-leaved *Viola palmata* (= *V. triloba*) will be found in mesic woodlands, and the wholly glabrous, almost fleshy-leaved *V. esculenta* to be limited to hydric stream bottoms. Once pressed, the evident distinctions largely disappear. Varietal status provides a taxonomic legitimacy to these differences.

Although the name *Viola esculenta* has long been used with reference to the succulent-leaved southeastern violet, the legitimacy of the combination has escaped scrutiny. The name has been assumed to have been formed by Stephen Elliott of Charleston, South Carolina, in his *A Sketch of the Botany of South-Carolina and Georgia* (1817). And indeed Elliott did provide a brief but unmistakable description: "...with the early leaves cordate, late ones hastate, with the lateral lobes sometimes divided, all rugose, crenate and glabrous; the middle lobe very large."

But Elliott did not employ the name *Viola esculenta* for his new violet. He placed it with others as varieties under the name *Viola palmata* Linnaeus. Under *V. palmata* var. *heterophylla* he then noted: "from the circumstance of its being eaten by negroes, I had called it *V. esculenta*, it is however the *V. heterophylla* of Muhlenberg..." Since a name is not validly published when it is not accepted by its author in the original publication (I.C.B.N., Art. 34.1), it is here rescued from oblivion by incorporation into a new name based on the same type and diagnosis.

Viola palmata* L. var. *esculenta* Elliott ex D. B. Ward, **nom. nov.*

Based upon *Viola esculenta* Ell., nom. illeg., Sketch 1:300.

1817. TYPE: Georgia, Ogeechee [River]. S. Elliott s.n.

(CHARL, not seen).

As a footnote to the above argument, the present action is not the first effort to restore legitimacy to Elliott's name. E. L. Greene (Pittonia 3:314. 1898), though he noted it to have been published only as a synonym, used "*V. esculenta*, Ell." A decade later the careful Ezra Brainerd (Bull. Torrey Bot. Club 37:588-589. 1910) also commented on the deficiency, and credited "effective publication" to Greene (1898). Later authors, by and large, have been oblivious to the original invalidity of Elliott's name.

The rules of the I.C.B.N. as to "effective" and "valid" publication are intentionally left vague, to accommodate inexact early writings.

Here, "valid publication" may be argued (Art. 32.3) to be met by Greene's use of the name, credited to Elliott. And, since not accepted by the original author, the published combination must be credited to the restoring author, with optional inclusion of the originator of the name. Thus *Viola esculenta* Elliott ex Greene (1898) is correct at specific rank.

The change in publication date of *V. esculenta*, from 1817 to 1898, is of possible significance in that other specific names applying to this taxon may have been published in the interim. The present action, of using the circumscription and type of the 1817 publication, creates a new name (at varietal level) and avoids questions of priority of the specific name.

The presence -- and distribution -- of *Viola sororia* Willdenow (1809) as reported here is in marked contrast to that given by McKinney (1992:34-39). McKinney provided a description, noting the pubescence to be "primarily strigose," that agrees with Willdenow's original diagnosis and is quite in line with populations in northern states known by that name. McKinney's Florida distribution extends throughout most of the state, with specimens cited as far south as Hillsborough and Polk counties in the central peninsula. Yet few specimens are known outside the panhandle that could reasonably be so identified. Those annotated with this name usually do show a few sparse hairs but are otherwise identical with *V. floridana*.

Viola floridana itself is here interpreted as an endemic, nearly restricted to the Florida peninsula. Though occasional collections from the eastern panhandle may be of this species, most panhandle plants so-called are *V. affinis*. *Viola affinis* in turn, though occasionally reaching the northern peninsula, is otherwise restricted to the panhandle. This understanding is in contrast to that of those (Russell, 1965; etc.) who viewed *V. floridana* as a widespread regional species, and of others (Wunderlin, 1998) who made no distinction whatsoever among *V. sororia*, *V. affinis*, and *V. floridana*. These three taxa admittedly intergrade, but they differ enough even in areas of geographic overlap to justify the rank of species. It is surely significant that Gil-Ad

(1998:117), using seed-coat morphology, was able to separate them without apparent difficulty, *V. floridana* so sharply differing from the other two that he considered it conspecific with the western *V. missouriensis* Greene. Even so, recent efforts by panhandle botanists have continued to encounter intermediates and uncertainties sufficient to hold the present interpretation of the Florida "stemless blues" to be preliminary and incomplete (James R. Burkhalter, Kathy C. Burks, Ann Johnson, pers. comm., April 2006).

The scientific name assigned to the Field Pansy, the annual violet found occasionally in north Florida, depends upon whether or not it is thought to be native to North America. This issue was considered significant by M. L. Fernald (*Rhodora* 40:443-446. 1938) who discussed it in detail, maintaining that the plant was little known to early American botanists and that its behavior was that of other "early-established weeds" of foreign origin; he concluded it was clearly introduced into North America. It was close to the Mediterranean *Viola kitaibeliana* Roemer & Schultes, though he was unable to match it exactly with specimens from Europe. He acknowledged the small differences by giving the American plants varietal status, as var. *rafinesquii* (Greene) Fern.

But others have been reluctant to abandon a presumption of native origin. Though he made no effort to refute Fernald's argument, H. A. Gleason (*Illust. Fl.* 2:566. 1952) returned the plant to specific status, using *V. rafinesquii*, a name unique to North America. L. H. Shinnars (*Rhodora* 63:327-335. 1961), responding to Fernald's discussion, pointed out in detail that the plant had indeed been known to early American authors, but was reported by those in the east to be of equivocal, perhaps introduced status, while those further west clearly treated it as native. Shinnars' conclusion was that it is a native American plant, with its major area in Texas, Arkansas, and Oklahoma, that has spread eastward as a weed.

Shinnars, as with Fernald, was unable to match the American plant with those of Europe; he saw this as further evidence of its native status. As such, he preferred specific rank, but found that the earliest specific

combination, *Viola bicolor* Pursh (1814), was antedated by *V. bicolor* Hoffmann (1804). He saw *V. rafinesquii* Greene (1899) as the correct name at specific rank.

Certainly, by examination of available specimens, the American plant, though not indistinguishable, is only subtly different from the Old World plant. And Shinnars' documentation of western records of nativity and movement eastward as a weed is difficult to explain away. Fernald's judgment seems sound as to rank of the American plant, and Shinnars' as to its introduced status in the eastern United States.

Long, happy hours in the woods of West Florida with Angus K. Gholson and the late Robert K. Godfrey have contributed both inspiration and informational content to this effort.

VIOLA L. Violets¹

1. Plants without elongated above-ground stems, the leaves and flowers arising from a rootstock or rhizome.
2. Corolla violet or purple (white in albino forms); rootstocks stout, fleshy; plants without stolons.
3. Leaves with 5-7 narrowly oblanceolate, shallowly-toothed lobes; hairs of beard on lateral petals short-pointed; cleistogamous capsules pale green to whitish, on erect peduncles; stems erect or nearly so (beneath soil and leaf litter); flowers large, purple. Perennial herb. Moist to dry pinelands. Panhandle and north Florida, south to

¹ The "amplified key" format employed here is designed to present in compact form the basic morphological framework of a conventional dichotomous key, as well as data on habitat, range, and frequency. This paper is a continuation of a series begun in the 1970s (vide *Phytologia* 35:404-413. 1977). Keys are being prepared for all genera of the Florida vascular flora, but the present "amplified" series is restricted to genera where a new combination is required or a special situation merits extended discussion.

mid-peninsula (Highlands, Lee counties): frequent.
Spring. [*V. palmata*, misapplied]

***Viola septemloba* LeConte**

3. Leaves unlobed or coarsely divided, with no more than 5 broad lobes; hairs of beard rounded or slightly clavate; stems inclined or near-horizontal (beneath litter).
4. Leaf blades with 3-5 broad lobes (except the earliest, which may be unlobed); cleistogamous capsules brown, on short prostrate peduncles. Perennial herb. Spring.

***Viola palmata* L.**

- a. Leaves angular, the apex and lobes acute, sparingly pubescent on veins, margins, and some petioles, thin. Dry hammocks. Central panhandle (Liberty County), eastward to north peninsula (Marion County). Frequent. [*V. chalcosperma*, misapplied; *V. triloba* Schwein.] var. ***palmata***
- a. Leaves rounded, the apex and lobes blunt, wholly glabrous, sometimes stiff and succulent. Moist hammocks, often by streams. Western and central panhandle (Escambia, Calhoun counties), east and south to central peninsula (Highlands County). Frequent. [*V. esculenta* Ell., illeg.] var. ***esculenta* Ell. ex D. B. Ward**
4. Leaf blades not lobed or divided.
5. Plants nearly or quite glabrous (or with a few scattered hairs on petiole if near and possibly introgressant with *V. sororia*).
6. Spurred petal (and lower lateral petals) bearded at throat; petals dark purple; scapes to 20 cm. long; plants in summer foliage relatively robust (>10 cm. tall). Perennial herb. Riverbottom forests. Western and central panhandle (Escambia to Jackson, Gadsden counties), to upper peninsula (Marion County) where perhaps adventive; infrequent. Spring. [*V. sororia* Willd. var. *affinis* (LeConte) McKinney]

***Viola affinis* LeConte**

6. Spurred petal beardless (lower lateral petals bearded at throat); petals lavender; scapes to 6 cm. long; plants in summer foliage of moderate size (<12 cm. tall). Perennial herb. Moist sandy soils of open hammocks, stream bottoms, lawns. North Florida, south to mid-peninsula (Highlands County, disjunct to Collier County); common (rare in panhandle). Spring. Endemic. [*V. chalcosperma* Brainerd; *V. missouriensis*, misapplied]

Viola floridana Brainerd

5. Plants variously pubescent.

7. Petioles heavily pubescent (hairs 0.5-1.0 mm. long), extending onto veins below, glabrous or nearly so above; spurred petal beardless; plants robust, older leaves rising to 10 cm. and above. Perennial herb. Dry open woodlands, bluffs. Central panhandle (Jackson to Leon counties), sparingly disjunct eastward (Alachua: Millhopper); rare. Spring.

Viola sororia Willd.

7. Petioles glabrous or minutely villous; plants small, the summer foliage <6 cm. in height.

8. Spurred petal beardless; flowers relatively large (petals 2.0-2.5 cm. long), borne well above leaves; leaves usually appressed to ground, purplish and glabrous below, densely puberulent above (with silvery sheen when fresh). Perennial herb. Dry woodlands. Panhandle (Escambia, Calhoun, Jackson, Calhoun, Liberty, Santa Rosa counties); rare. Spring.

Viola hirsutula Brainerd

8. Spurred petal bearded; flowers relatively small (petals 1.2-2.0 cm. long), borne with or below leaves; leaves spreading, finely pubescent below and on margins and veins above, green below and above. Perennial herb. Dry oak woodlands. Central panhandle (Calhoun County) east to north peninsula (Alachua, Levy counties); infrequent. Spring.

Viola villosa Walt.

2. Corolla white, the petals often with dark lines; rootstocks slender, fibrous; plants often with stolons.

9. Leaf blades broadly elliptic to cordate-ovate, 1.5-2 times as long as broad. Perennial herb. Moist sandy soils, usually under pines. North Florida, south to lower peninsula (Lee, Palm Beach counties); frequent. Spring. [*V. rugosa* Small]
***Viola primulifolia* L.**

9. Leaf blades oblanceolate to linear, 6-12 times as long as broad. Perennial herb. Wet sands of pine woodlands, pond margins. Nearly throughout, common (rare in s. peninsula, absent in Keys). [*V. vittata* Greene]

***Viola lanceolata* L.**

var. ***vittata*** (Greene) Weath. & Grisc.

1. Plants with elongated leafy stems, either erect or trailing.

10. Plants perennial; stipules entire; style scarcely enlarged at the tip.

11. Petals yellow, purple tinged on back; leaves ovate, the apex long-tapering, the base rounded to truncate, often variegated with silvery-gray patches; stems ascending-erect. Perennial herb. Rich moist wooded slopes. Central panhandle (Gadsden, Liberty counties); rare. Spring. ENDANGERED (State listing); two known colonies. [*V. hastata*, misapplied]

***Viola tripartita* Ell.**

var. ***glaberrima*** (Ging.) Harper

11. Petals pale violet-blue; leaves small, orbicular, usually purple beneath with purple veins above; stems commonly trailing. Perennial herb. Moist hammocks. Central panhandle (Jackson County), eastward to north peninsula (Alachua County, disjunct to Citrus County); common. Spring.

***Viola walteri* House**

10. Plants annual; stipules pectinately divided; style much enlarged upwards.

12. Petals light to deep violet, the center yellow or white with violet stripes; pectinate stipules with middle lobe linear to linear-spatulate, entire; leaves crenate, orbicular at base of plant, broadly ovate above. Annual herb. Sandy riverbanks, lake margins, roadsides. West and central panhandle (Escambia, Okaloosa counties, east to Jackson,

Leon counties); infrequent, but often locally abundant.

Spring. [*V. bicolor* Pursh; *V. rafinesquii* Greene]

FIELD PANSY. * *Viola kitaibeliana* Roem. & Schult.

var. *rafinesquii* (Greene) Fern.

12. Petals cream or orange-yellow, the upper two usually purple-tipped; pectinate sepals with middle lobe spatulate or oblong-spatulate, distinctly crenate to serrate; leaves crenate to serrate, elliptic at base of plant, narrowly ovate above. Annual herb. Disturbed soils. Panhandle (Calhoun, Franklin, Santa Rosa counties); rare. Spring. WILD PANSY. * *Viola tricolor* L.

Excluded names:

***Viola conspersa* Reichenb.**

Dog Violet.

Northern. Found only once, in Leon Co. (Godfrey 59336 - FSU); retained by Clewell (1985) and Wunderlin (1998), based on this spm. No longer present when site was revisited in 1985 (R. K. Godfrey, with D. B. W.).

***Viola cucullata* Ait.**

Marsh Violet.

Reported for Jefferson and Liberty counties, on basis of annotations by H. E. Ballard (Anderson, 1984; Clewell, 1985:523). Misidentified; cited spms. appear to be *V. affinis*. Russell (1965) and McKinney (1992) found no *V. cucullata* south of northern Georgia.

***Viola fimbriatula* J. E. Sm.**

Reported for Florida by Small (1933). No spms. are known south of North Carolina and northern Alabama (Russell, 1965; McKinney, 1992).

***Viola hastata* Michx.**

Reported for Florida by Small (1933), without documentation. Recorded for Gadsden Co. (Ward, 1979; Clewell, 1985; Wunderlin, 1998), on basis of spms. from a single small population discovered by R. K. Godfrey. Misidentified; the plants are *V. tripartita* (q.v.). Russell (1965) found no true *V. hastata* south of northern Georgia. Curiously, Small (Bull. Torrey Bot. Club 24:487-496. 1897) had discussed at length erroneous reports of the "Alleghenian" *V.*

hastata in Florida, on the basis of misidentified *V. tripartita*; did he forget his own earlier writing?

***Viola langloisii* Greene**

Reported for Florida by Russell (1965), with spms. (FLAS) so annotated. But plants matching his description cannot be found in the field. Florida plants so named may perhaps best be referred to young *V. floridana*.

***Viola papilionacea* Pursh**

Reported for Florida by Small (1933) and others. But a "mythical" species, a catch-all for almost any glabrous or near-glabrous stemless blue violet with uncut leaves (Russell, 1965). Apparently most plants so-called are hybrids involving *V. affinis*, *V. cucullata*, and *V. sororia* (Gil-ad, 1998). The name seems not applicable to Florida plants.

***Viola pedata* L.**

Bird's-foot Violet.

Northern. Reported for Florida by Small (1933). No spms. from the state were seen by Russell (1965) or McKinney (1992).

OVERVIEW OF THE GENUS *BAPTISIA* (LEGUMINOSAE)

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ABSTRACT

Preparation of a treatment of *Baptisia* for the Flora of North America (FNA) has occasioned the present study. Seventeen species are recognized, three of these each having two allopatric intergrading varieties: *B. australis* (varieties *australis* and *minor*); *B. lactea* (varieties *lactea* and *pendula*); and *B. lanceolata* (varieties *lanceolata* and *elliptica*). Maps showing the distribution of all taxa by state and county are provided, largely because the FNA format shows the distribution of taxa by state only (a single dot centered in the center of a state's outline). My overview follows closely the treatments accorded the genus by Isely (1981, 1998), except that I have arranged these by clades, as suggested by the study of Mendenhall (1994). Additionally, I have had to erect two new names for the complex, as follows: ***B. lactea* var. *pendula*** (Larisey) B.L. Turner, **comb. nov.** (= *B. lactea* var. *obovata* [Larisey] Isely); and ***B. lanceolata* var. *elliptica*** (Small) B.L. Turner, **comb. nov.** (= *B. lanceolata* var. *tomentosa* (Larisey) Isely).

KEY WORDS: *Baptisia*, Leguminosae, Fabaceae

Isely (1981) provided a rather detailed , excellent account of *Baptisia* in which 15 species were recognized, some of these with several infraspecific taxa. This treatment was modified (but not improved upon) in his account of the Leguminosae for the United States (Isely 1998). In my treatment of *Baptisia* for FNA I have added additional taxonomic frills, including revised keys and geographical enhancements, these based upon distribution at the county level, as shown here in. Data for the latter were obtained from various sources, mainly that of Larisey (1941), Isely (1981, 1998), and various floras of the region concerned.

In the account that follows, I have arranged the taxa by phyletic groupings according to the cladistic analyses of Mendenhall (1994) in which a large assemblage of data, including that of DNA, was brought to bear on the subject. In particular, I largely relied upon her Fig. 21 ("A single most parsimonious tree generated using combined character sets."), this agreeing well with my particular intuitive assessments of relationships within the genus. In my forth coming treatment for FNA, a more detailed treatment of the taxa is provided, including a key to the taxa concerned; in this I recognize the following taxa:

B. ALBA -B. TINCTORIA CLADE:

1. *Baptisia alba* (L.) Ventanat Fig. 1

The genus is typified by this species. The name itself is lectotypified by an illustration cited by Linnaeus (Martyn, Hist. Pl. Rar. 44, t. 44. 1728). Reveal (per. comm.) sent me a xerox (TEX) of a Carolina plant grown from seed in 1729 and sent by Mark Catesby to Europe (BM) which closely matches the illustration of the lectotype. While the illustration of the fruit on the lectotype is ambiguous, the pod seemingly standing somewhere between *B. lactea* and *B. alba*, the flowers and leaves of the Catesby collection appear to match those of the illustration concerned. After viewing this I have little hesitation in attaching the lectotype to *B. alba*. Isley (1981) also accepted *B. alba* in this sense, but subsequently Isely (1998) applied the latter name to what I call *B. lactea*, taking up the name *B. albescens* for what he had earlier referred to as *B. alba*. In my opinion, *B. albescens* is a synonym of the much earlier *B. alba*. The latter species occurs throughout most of South Carolina; *B. lactea*, however, is relatively rare and confined to the more western parts of South Carolina, and seeds from this taxon are unlikely to have been collected by the early collectors in the state.

2. *Baptisia lactea* (Rafinesque) Theiret Figs 2, 3

My circumscription of this taxon is about the same as that of Isley (1981), except that I apply the varietal name *pendula* to what

he calls var. *obovata*, this necessitated under the current Code of Botanical Nomenclature (Art 11.6), as noted below.

Baptisia lactea var. **pendula** (Larsey) B.L. Turner, comb. nov.

Based upon *Baptisia pendula* Larisey, Ann. Missouri Bot. Gard. 27: 170. 1940.

When *Baptisia pendula* var. *obovata* Larisey was first described, the varietal name *pendula* was also created, this then being the correct name for the infraspecific category concerned.

3. **Baptisia sphaerocarpa** Nuttall Fig. 4

My treatment of this yellow-flowered species follows that of Isely (1981,1998).

4. **Baptisia australis** (Linnaeus) R. Brown Fig. 5

Isely (1981, 1998) treated this widespread, blue-flowered, species as having two intergrading varieties as shown in Fig. 5. I also accept this interpretation. Mendenhall (1994), however, recognized var. *minor* at the specific level, including within it two varietal taxa, a widespread var. *minor*, and a more localized var. *aberrans* (from cedar glade habitats of Tennessee). I consider the latter taxon to belong to the typical var. *australis*, although Mendenhall accepted its varietal status.

5. **Baptisia megacarpa** Torrey & A. Gray Fig. 6

This relatively localized, yellow-flowered, endemic was positioned by Mendenhall (1994) within the present clade. Isely (1981,1998) also thought its relationships to be with the *B. alba* – *B. lactea* complex.

6. **Baptisia tinctoria** (Linnaeus) Ventenat Fig. 7

My interpretation of this widespread, yellow-flowered, species

follows that of Isely (1981, 1998).

SIMPLE - LEAFED CLADE

7. *Baptisia arachnifera* Duncan Fig. 8

This relatively recently described, yellow-flowered, species is known only from Brantley and Wayne counties, Georgia.

8. *Baptisia simplicifolia* Croom Fig. 9

This localized yellow-flowered species is endemic to the more eastern parts of the Panhandle Region of Florida.

9. *Baptisia perfoliata* (Linnaeus) R. Brown Fig. 10

This is a very distinctive, yellow-flowered species, not easily confused with another.

B. NUTTALLIANA– B. LANCEOLATA CLADE

10. *Baptisia nuttalliana* Small Fig. 11

My treatment of this yellow-flowered species follows that of Isely (1981, 1999).

11. *Baptisia lanceolata* (Walter) Elliott Fig. 12, 13

My treatment of this yellow-flowered species mirrors that of Isely (1981, 1994) in which two intergrading varieties are recognized: the typical var. *lanceolata*, and *B. lanceolata* var. ***elliptica*** (Small) B.L. Turner, **comb. nov.**

Based upon *B. elliptica* Small, Fl. Southeast. U.S., ed. 1, 599, 1331. 1903.

Isely (1981, 1998) used the synonymous *B. lanceolata* var. *tomentosa* (Larisey) Isely in place of the var. *elliptica*, this contrary

to Art.11.6. of the current Code (cf. above discussion of *B. lactea*).

B. LEUCOPHAEA – B. BRACTEATA CLADE

12. *Baptisia leucophaea* Nuttall Fig. 14

Isely (1981, 1998) included this yellow-flowered taxon within his concept of *B. bracteata* (as *B. b.* var. *laevicaulis*, although the correct name at that rank should be var. *leucophaea*). He also recognized a var. *glabrescens* under the fabric of his *B. bracteata*. I recognize both *B. bracteata* and *B. leucophaea* as good species, the latter conceived as widespread and highly variable, lacking well-defined infraspecific taxa. *Baptisia bracteata* is confined to the southeastern U.S. and does not appear to intergrade with *B. leucophaea*. However, the two are clearly closely related, both possessing bracteate, secund, reflexed racemes.

13. *Baptisia bracteata* Elliott Fig. 15

This yellow-flowered species is confined to the southeastern U.S. Isely (1981, 1998) included *B. leucophaea* within its parameters, as noted in the above.

14. *B. cinerea* (Rafineque) Fernald & Schubert Fig. 16

My concept of this yellow-flowered category follows that of Isely (1981,1998).

B. CALYCOSA – B. HIRSUTA CLADE

15. *B. calycosa* Canby Fig. 8

This highly localized species is endemic to northeastern Florida. Isely (1981, 1998) included within its fabric (as a variety) *B. villosa* Canby, but I treat the latter as a good species, *B. hirsuta*, this the correct name when treated at the specific level.

16. *B. hirsuta* Small Fig. 17

A noted in the above, Isely (1981,1998) treated this taxon within his concept of *B. calycosa*.

17. *B. lecontei* Torrey & A. Gray Fig. 18

Baptisia lecontei clearly belongs to the yellow-flowered *B. calycosa* clade, as well noted by Mendenhall (1994).

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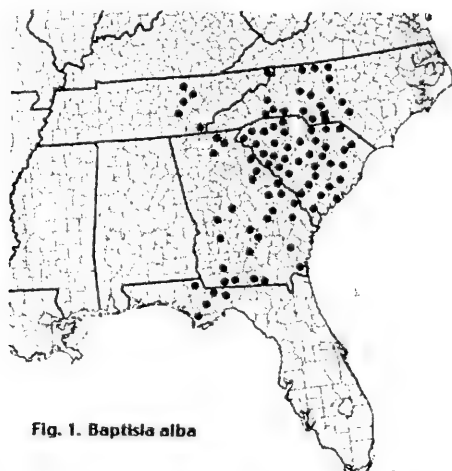
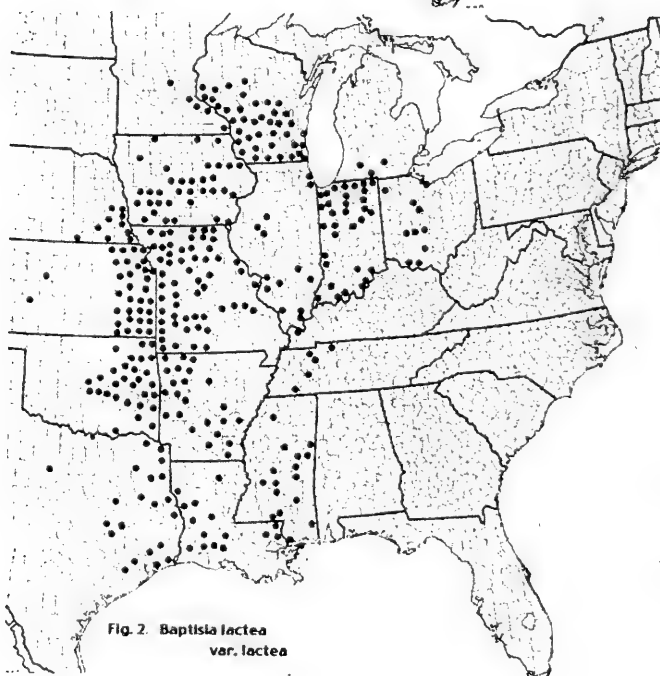
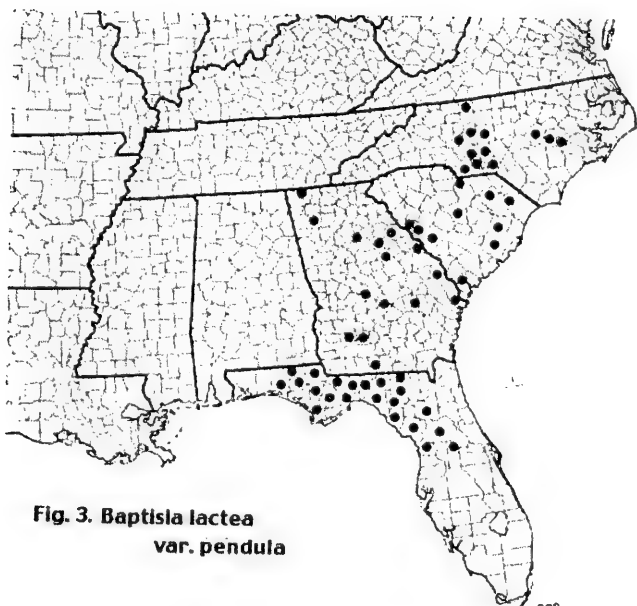


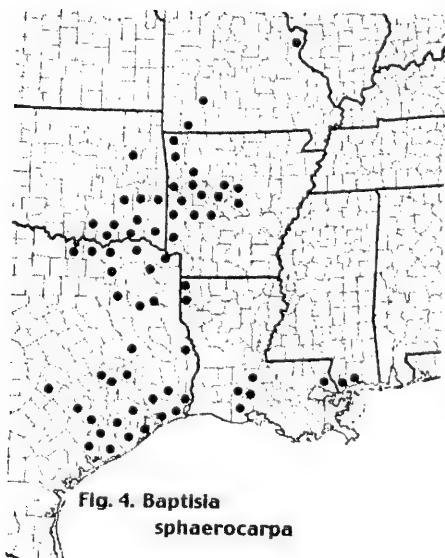
Fig. 1. *Baptisia alba*



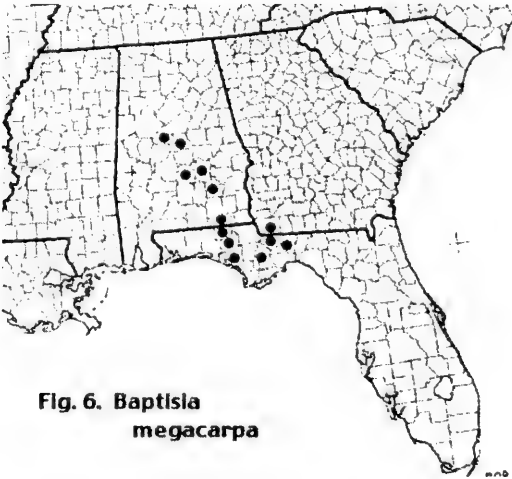
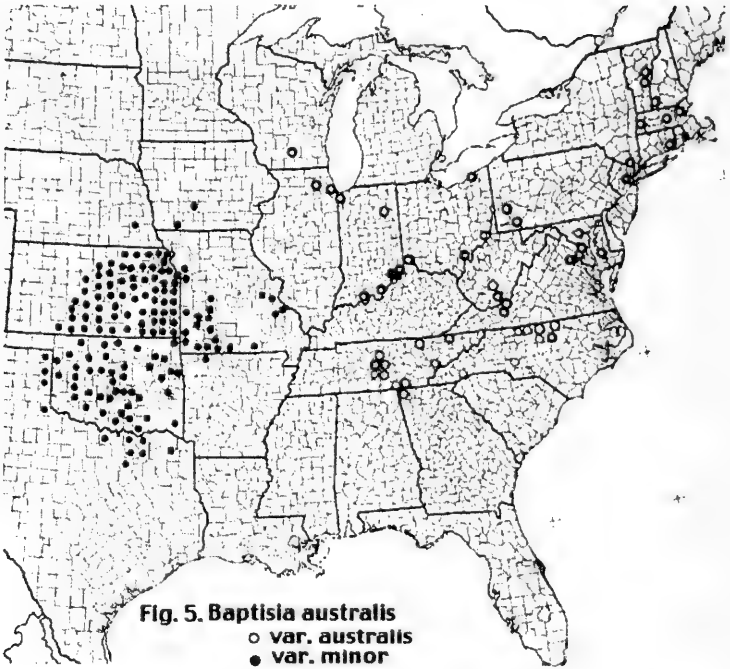
**Fig. 2. *Baptisia lactea*
var. *lactea***

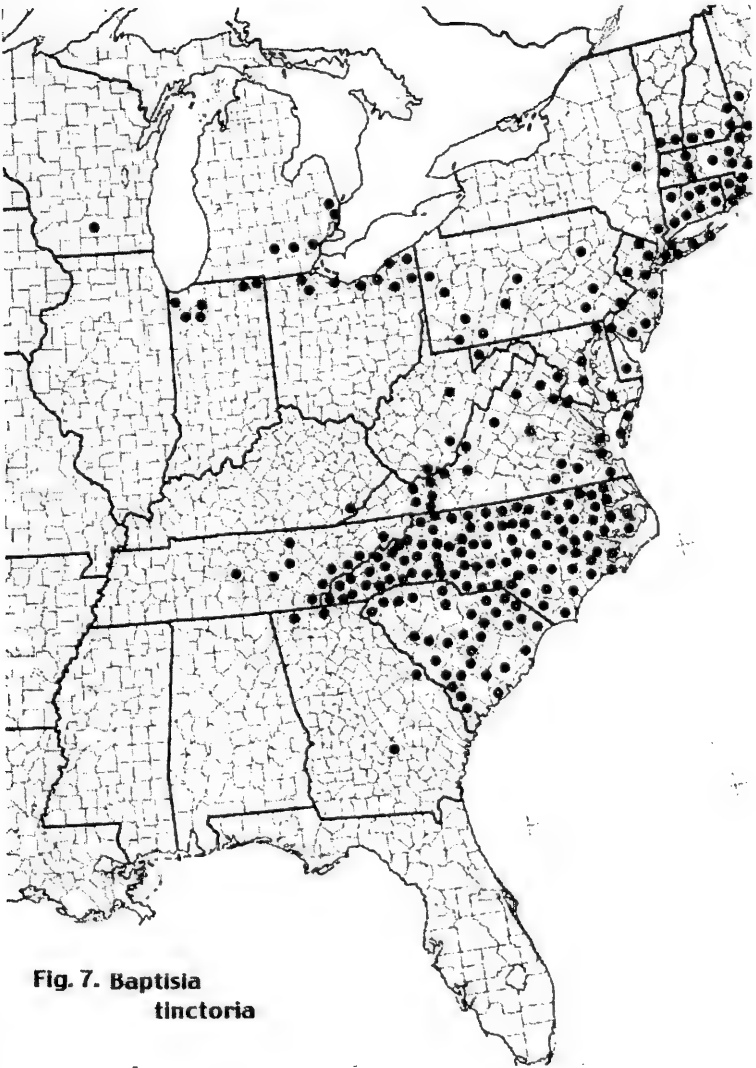


**Fig. 3. *Baptisia lactea*
var. *pendula***

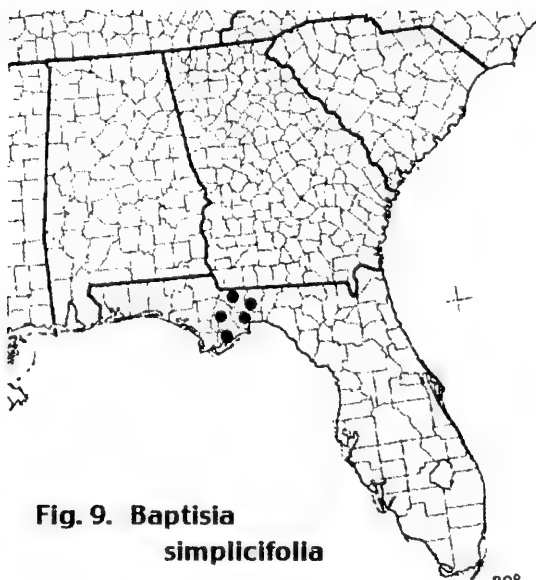
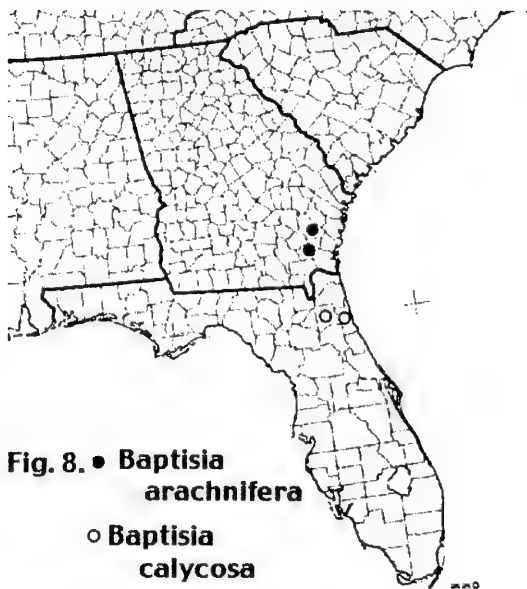


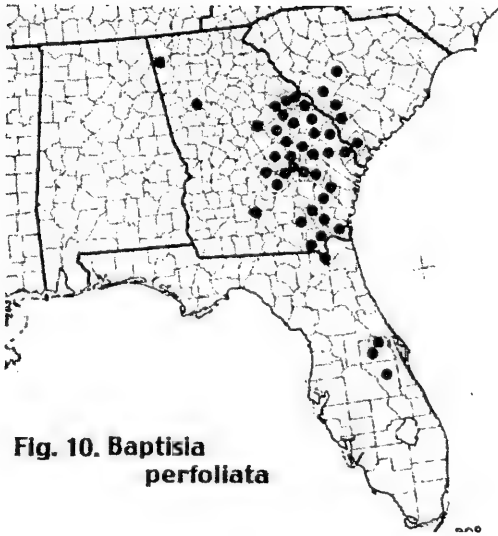
**Fig. 4. *Baptisia*
*sphaerocarpa***



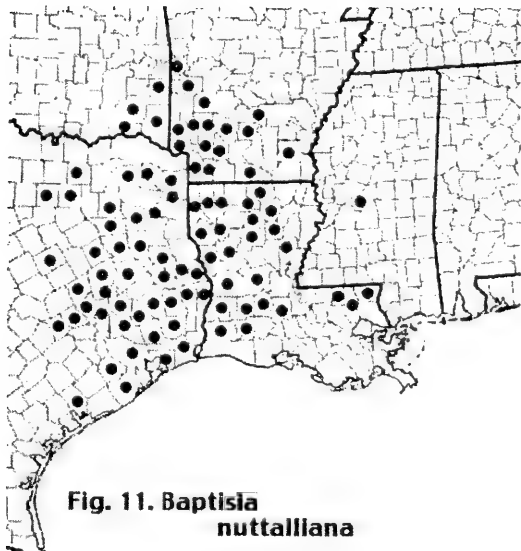


**Fig. 7. *Baptisia*
*tinctoria***

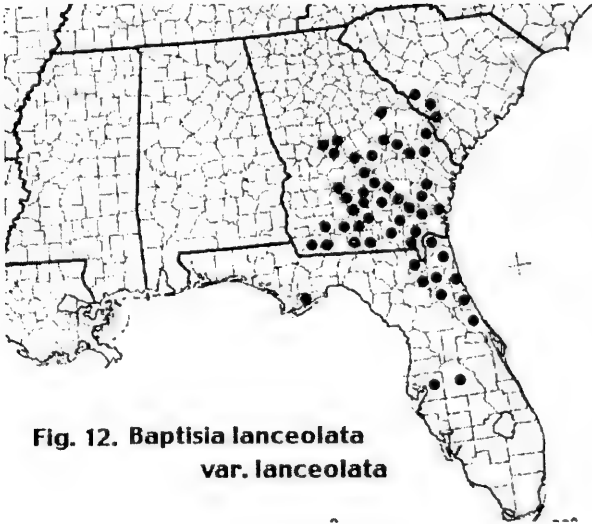




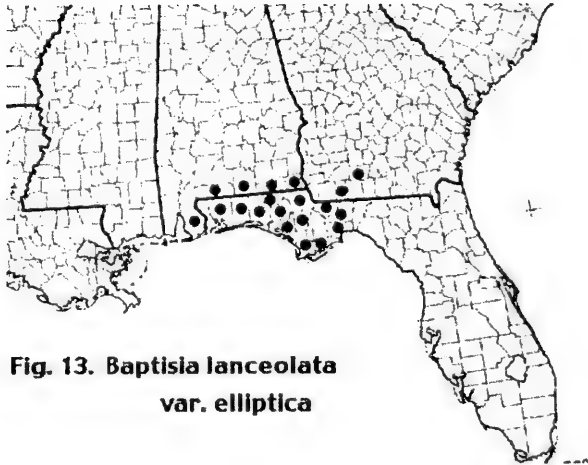
**Fig. 10. *Baptisia*
*perfoliata***



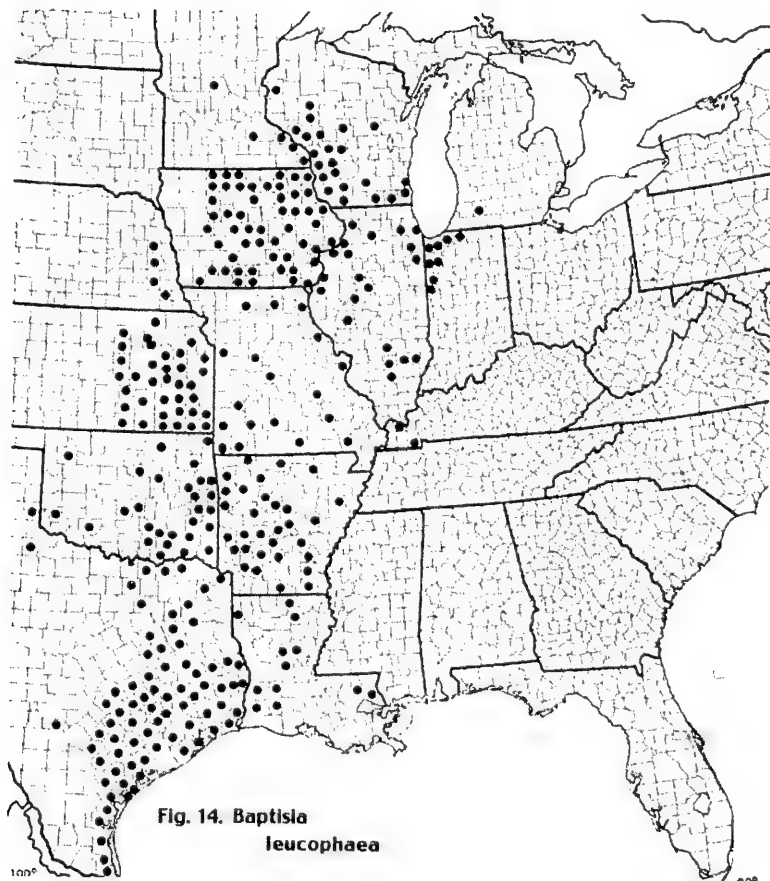
**Fig. 11. *Baptisia*
*nuttalliana***

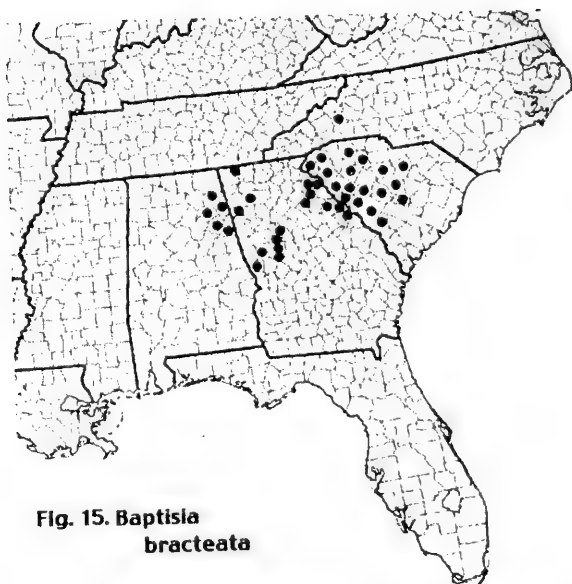


**Fig. 12. *Baptisia lanceolata*
var. *lanceolata***

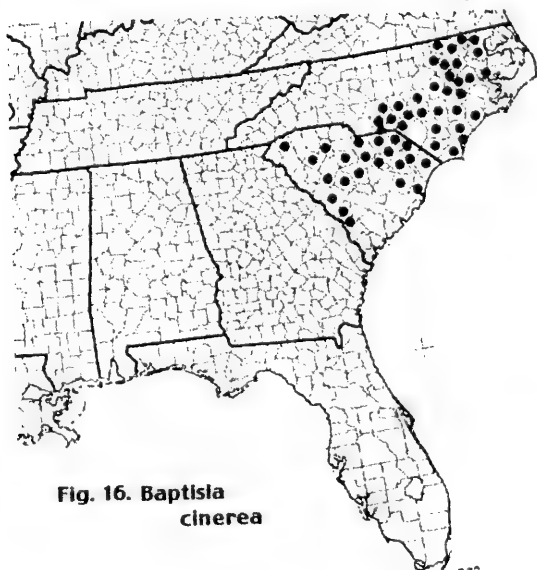


**Fig. 13. *Baptisia lanceolata*
var. *elliptica***

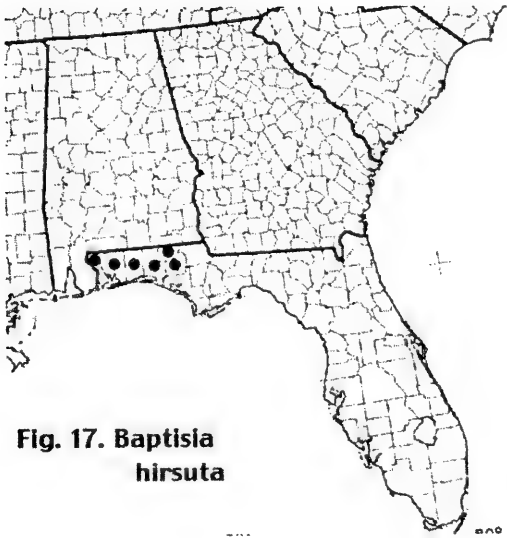




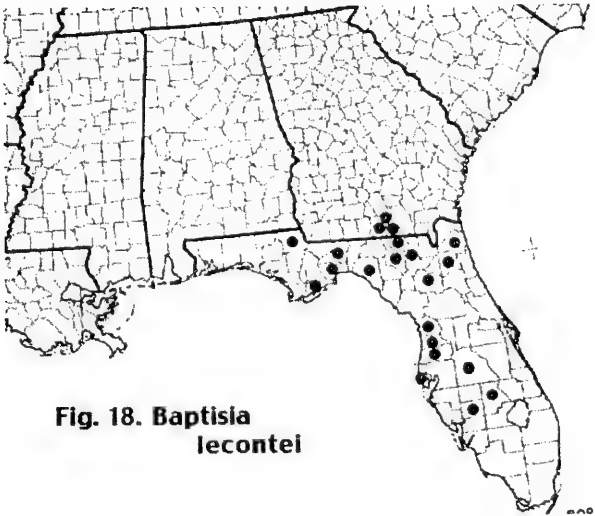
**Fig. 15. *Baptisia
bracteata***



**Fig. 16. *Baptisia
cinerea***



**Fig. 17. *Baptisia*
*hirsuta***



**Fig. 18. *Baptisia*
*lecontei***

GEOGRAPHIC VARIATION IN *JUNIPERUS PHOENICEA* FROM THE CANARY ISLANDS, MOROCCO AND SPAIN, BASED ON RAPDS ANALYSIS

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ABSTRACT

Populations of *J. phoenicea* var. *phaenicea* and *J. p.* var. *turbinata* from the Canary Islands, Morocco, and Spain were analyzed by Random Amplified Polymorphic DNAs (RAPDs). The Canary Islands and Moroccan populations were very similar to *J. p.* var. *turbinata* from Tarifa, Spain. The largest divergence from *J. p.* var. *turbinata* was in the high Atlas Mtns., Morocco population. Although the Canary Islands population is somewhat divergent, it is treated as *J. p.* var. *turbinata* rather than *J. p.* var. *canariensis*. There is insufficient support to merit the recognition of *J. p.* var. *canariensis*, *J. p.* var. *megalocarpa* or *J. p.* var. *mollis*.

KEY WORDS: *Juniperus phoenicea*, Cupressaceae, geographic variation, RAPDs.

Juniperus phoenicea L. is a small tree that is native to the northern Mediterranean from Portugal to Israel (Adams, 2004). It is also native to North Africa in Algiers and Morocco as well as the Canary Islands (Adams, 2004). Gaussen (1968) discussed several infraspecific taxa: *J. p.* var. *turbinata* (Guss.) Parl.(= *J. p.* var. *oophora* Kunze) with female cones elongated (turbinata) in littoral sites throughout the Mediterranean; *J. p.* var. *canariensis* Guyot on the Canary Islands; var. *lycia* (L.) Gaussen

(*pro specie*) (= *J. phoenicea*), France littoral zone; var. *mollis* M & W., common in Morocco; and var. *megalocarpa* Maire, dunes near Mogador (now Essaouira), Morocco. Later, LeBreton and Thivend (1981), on the basis of total proanthocyanidins and the ratio of procyanidine to prodelphinidine, recognized *J. phoenicea* subsp. *eu-mediterranea* Lebr. & Thiv. as occurring on the Mediterranean islands, North Africa and southwestern Portugal. LeBreton (1983) expanded his work to include more sample locations and showed all of the southwestern coastal populations of Portugal and Spain to have high proanthocyanidins (implying *J. p.* subsp. *eu-mediterranea*).

Adams, Barrero and Lara (1996) sampled plants from the area of LeBreton's population 70, his pure *J. phoenicea* population (66-65) and *J. p.* var. *turbinata* from Tarifa as well as a reference population of *J. phoenicea* in Greece. Based on leaf essential oils, Adams, Barrero and Lara (1996) concluded that *J. phoenicea* var. *turbinata* and *J. p.* subsp. *eu-mediterranea* were conspecific.

Recently, Rezzi et al. (2001) reported on infraspecific variation in the leaf essential oils of *J. phoenicea* var. *turbinata* from Corsica. They found two chemical types: high α -pinene, low β -phellandrene, low α -terpinyl acetate (cluster I, 35 indivs.); and low α -pinene, high β -phellandrene, high α -terpinyl acetate (Cluster II, 15 indivs.). No morphological differences were found.

Adams et al. (2002) analyzed the RAPDs of *J. phoenicea* from Portugal (*J. p.* subsp. *eu-mediterranea*), Spain, Canary Islands, Corsica, and Greece. They found that *J. phoenicea* was clearly divided into var. *phoenicea* and var. *turbinata* and affiliated populations. *Juniperus p.* subsp. *eu-mediterranea* from Portugal was confirmed to be conspecific with *J. p.* var. *turbinata*. By nomenclatural priority, *J. p.* subsp. *eu-mediterranea* is a synonym of *J. p.* var. *turbinata*. Putative *J. p.* var. *canariensis* from the Canary Islands showed a strong affinity to plants from southern Greece and to *J. p.* var. *turbinata* plants. Based on RAPDs data and morphological observations, only two infraspecific taxa of *J. phoenicea* are recognized: var. *phoenicea* and var. *turbinata*.

Random Amplified Polymorphic DNAs (RAPDs) have been used in several *Juniperus* studies and have proved useful in systematics (Adams, 1999, 2000a-d, 2001) when stringent laboratory procedures are followed (Adams, Flournoy and Pandey, 1998). In the present study, plants were analyzed from several of the aforementioned populations (Adams et al., 2002), plus collections of putative *J. p.* var. *megalocarpa*,

Essaouira, and *J. p. var. mollis*, high Atlas Mtns., Morocco.

MATERIALS AND METHODS

Specimens collected: *J. phoenicea*: 25 km e. Guadahortuna, 720 m, El Penon, Spain, R. P. Adams, 7077-7079; putative *J. p. var. phoenicea*: 20 km sse Marrakech, 940 m, 30° 21.033'N, 07° 45.893'W, Morocco; *J. phoenicea var. turbinata*: Tarifa sand dunes, 30 m, 36° 04.996'N, 5° 42.104' W, 15 km w. of Tarifa, Spain, R. P. Adams, 7202-7204; putative *J. phoenicea var. turbinata*, ca. 150 m, volcanic rock, Tenerife, Canary Islands, R. P. Adams 8147-8149; sand dunes; ca. 180 m, 31° 30'N, 9° 47' W, 6 km e. Essaouira, Morocco, N. Achak & R. P. Adams 10407-10411. Voucher specimens are deposited at BAYLU.

One gram (fresh weight) of the foliage was placed in 20 g of activated silica gel and transported to the lab, thence stored at -20° C until the DNA was extracted. DNA was extracted using the Qiagen DNeasy mini kit (Qiagen Inc., Valencia CA). The RAPD analyses follow that of Adams and Demeke (1993). Ten-mer primers were purchased from the University of British Colombia (5'-3'): 134, AAC ACA CGA G; 153, GAG TCA CGA G; 184, CAA ACG GAC C; 212, GCT GCG TGA C; 218, CTC AGC CCA G; 239, CTG AAG CGG A; 249, GCA TCT ACC G; 250, CGA CAG TCC C; 268, AGG CCG CTT A; 338, CTG TGG CGG T; 346, TAG GCG AAC G; 347, TTG CTT GGC G; 375, CCG GAC ACG A; 431, CTG CGG GTC A; 478, CGA GCT GGT C.

PCR stock solutions (Taq, primer, buffer) were made in bulk so that all the PCR reaction tubes for a primer were prepared using the same bulk stock. This is a critical factor for minimizing variation in band intensities from sample to sample (see Adams, Flournoy and Pandey, 1998, for protocols to minimize PCR band variation). PCR was performed in a volume of 15 µl containing 50 mM KCl, 10 mM Tris-HCl (pH 9), 2.0 mM MgCl₂, and 0.1% Triton X-100, 0.2 mM of each dNTPs, 0.36 µM primers, 0.3 ng genomic DNA, 15 ng BSA and 0.6 unit of Taq DNA polymerase (Promega). A negative control PCR tube containing all components, but no genomic DNA, was run with each primer to check for contamination. DNA amplification was performed in an MJ Programmable Thermal Cycler (MJ Research, Inc.). Samples were run in duplicate to insure reproducibility (Adams, Flournoy and Pandey, 1998). A temperature profile was obtained for each well of the thermocycler to be sure that no variation existed among wells in the heating/cooling block. The thermal cycle used was: 94°C (1.5 min) for initial strand separation, then 40 cycles of 40°C (2 min), 72°C (2 min), 91°C (1 min). Two

additional steps were used: 40°C (2 min) and 72°C (5 min) for final extension. The temperature inside a PCR tube with 15µl buffer was monitored with a temperature probe for each step for each of the 40 cycles (Adams, Flournoy and Pandey, 1998) to insure that each cycle met temperature specifications and that each PCR run was exactly the same. Amplification products were analyzed by electrophoresis on 1.5% agarose gels, 75V, 55 min, and detected by staining with ethidium bromide. The gels were photographed over UV light using Polaroid film 667 and scanned to digital images. The digital images were size normalized in reference to pGem® DNA size markers before band scoring. Bands were scored as present (1) and absent (0). Bands that were inconsistent in replicate analyses were not scored.

Associational measures were computed using absolute character state differences (Manhattan metric), divided by the maximum observed value for that character over all taxa (= Gower metric, Gower, 1971; Adams, 1975). Principal coordinate analysis (PCO) was performed by factoring the associational matrix using the formulation of Gower (1966) and Veldman (1967). It should be noted that problems of homology of RAPD DNA bands on agarose gels can be significant (Rieseberg, 1996), but these errors can be accounted for using multivariate statistical methods (PCO) (see Adams and Rieseberg, 1998). A minimum spanning diagram was constructed by selecting the nearest neighbor for each taxon from the pair-wise similarity matrix, then connecting those nearest neighbors as nodes in a network that was superimposed on a geographic map (Adams et al. 2003).

RESULTS AND DISCUSSION

The major trend in the minimum spanning network (Fig. 1) is the separation of *J. phoenicea* var. *phoenicea* (El Penon, Spain) from *J. p.* var. *turbinata* (Tarifa sand), Morocco and Canary Island populations. The Tarifa, Canary Islands, and Morocco populations are each distinct and relatively uniform within populations (Fig. 1).

Factoring the association matrix resulted in four eigenroots of 40.6%, 20.3%, 13.5% and 10.35% that accounted for 84.7% of the variance among samples. A major portion of the variation (40.6%) is due to the separation of *J. p.* var. *phoenicea* (El Penon, Spain) from the other four populations (Fig. 2). The other four populations (Fig. 2) form a loose assemblage with no apparent subgroups.

Minimum Spanning Network
111 RAPD bands

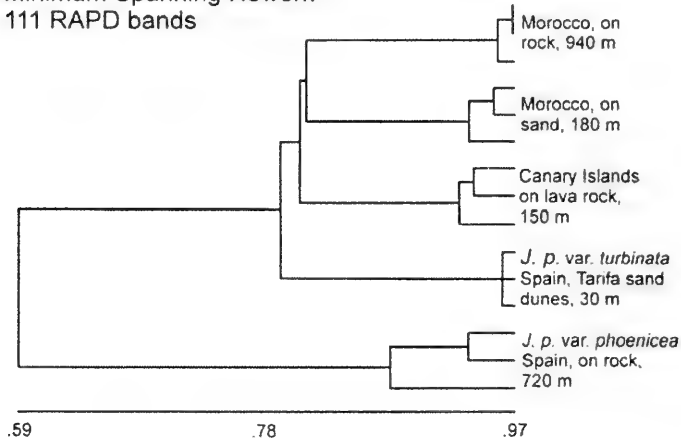


Figure 1. Minimum spanning network based on 111 RAPD bands. Two major groups are apparent: *J. p. var. phoenicea* and *J. p. var. turbinata*. The Tarifa, Canary Islands and two Moroccan populations are each distinct.

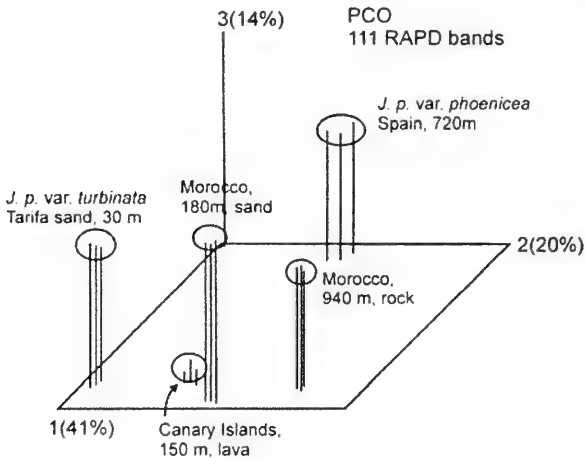


Figure 2. PCO for *J. p. var. phoenicea*, *J. p. var. turbinata* and associated populations. See text for discussion.

Contouring the similarities among populations shows a similar trend (Fig. 3) in which the southernmost populations (C, Canary Islands; E, Essaouira, Morocco; A, Atlas Mtns., Morocco) cluster at 0.808 similarity. Next, the *J. p. var. turbinata* population from the Tarifa sand dunes, Spain (T, Fig. 3) joins the cluster at 0.793. *Juniperus p. var. phoenicea* (P, El Penon, Spain, Fig. 3) is loosely associated at 0.590. Clearly, the Canary Island and Moroccan populations have strong affinities to var. *turbinata* (T, Fig. 3), rather than to var. *phoenicea* (P, Fig. 3).

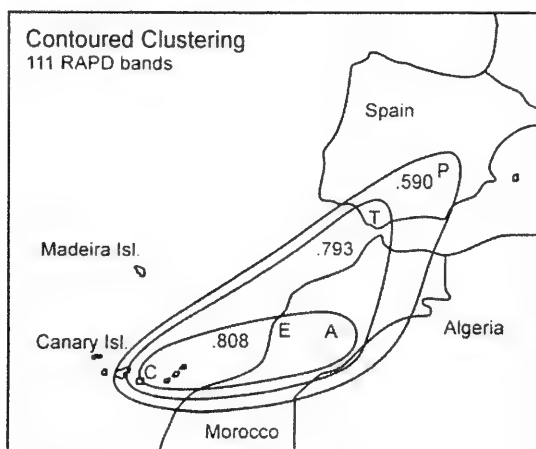


Figure 3. Contoured clustering shows that the southern populations (C = Canary Islands, E = Essaouira, Morocco, A = Atlas Mtns., Morocco) form a cluster followed by the Tarifa (T) population (*J. p. var. turbinata*) with *J. p. var. phoenicea* (P = El Penon, Spain) loosely associated.

A similar trend is seen in the minimum spanning network (Fig. 4). Notice the same similarity between Essaouira (E) - Atlas Mtns. (A) as for Essaouira (E) - Canary Islands (C) populations (E-A, E-C, each 0.808). The link from the Canary Islands to *J. p. var. turbinata*, Tarifa sands, Spain is only slightly less (C-T, 0.793) than the other linkages. *Juniperus p. var. phoenicea* (P, El Penon, Spain) links at a much lower level to the Canary Islands population (P-C, 0.590). To examine the divergence of

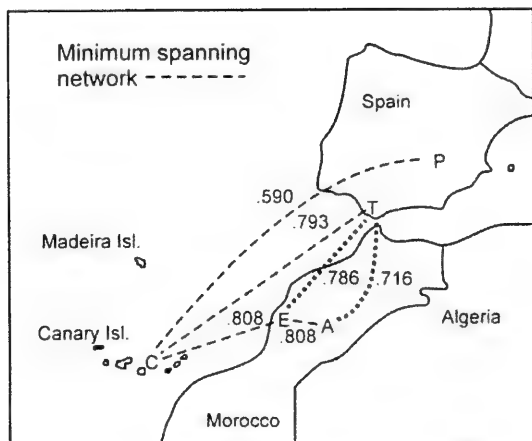


Figure 4. Minimum spanning (dashed lines) show the linkage order among populations. The dotted lines show the secondary linkages between Tarifa - Essaouira, and Tarifa - Atlas Mtns. See text for discussion.

the Moroccan and Canary Islands populations from typical *J. p. var. turbinata*, the linkages from Tarifa (T) to the Moroccan populations were mapped (Fig. 4, dotted lines). The Tarifa population is much less similar to the Atlas Mtns. (T-A, 0.716), than to Essaouira (T-E, 0.786). So, although Essaouira has the same similarity to both the Canary Islands and Atlas Mtns. populations (0.808), Essaouira plants are more similar to *J. p. var. turbinata* and less similar to the Atlas Mtns. plants.

CONCLUSIONS

Adams et al. (2002), in a the previous study involving *J. p. var. phoenicea*, *J. p. var. canariensis*, and *J. p. var. turbinata*, concluded that although *J. p. var. canariensis* had some distinct DNA differences, it did not merit recognition as a variety. However, they did not include materials from Morocco. Gaussen (1968) recognized var. *canariensis* on the Canary Islands; var. *mollis*, common in Morocco; and var. *megalocarpa*, on dunes near Mogador (= Essaouira), Morocco. In this study, we have collected materials from var. *megalocarpa* (Essaouira)

and var. *mollis* (Atlas Mtns.) and analyzed the DNA fingerprints from these plants. The Canary Islands, Essaouira and Atlas Mtns. populations were found to be somewhat divergent from var. *turbinata*, but basically there seem to be two meaningful entities, var. *phoenicea* and var. *turbinata*. We conclude that there is insufficient support for the recognition of *J. p.* var. *canariensis*, var. *megalocarpa*, or var. *mollis*. It is surprising to find var. *turbinata* in the high Atlas Mtns. (940 m), as it is has traditionally been associated with coastal habitats. It is likely that the Moroccan populations were part of a refugium for *J. phoenicea* during the Pleistocene glacial ages.

ACKNOWLEDGEMENTS

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**TAXONOMY AND NOMENCLATURE OF THE *ERYSIMUM*
ASPERUM-*E. CAPITATUM* COMPLEX (BRASSICACEAE)**

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ABSTRACT

The *Erysimum asperum-capitatum* complex includes a vast array of taxa in the western U.S.A. and Mexico, most of these bearing specific or infraspecific names, and all to some extent intergrading in regions of allopatry. These appear to be best treated as belonging to but a single species, *Erysimum asperum*, with two subspecies: subsp. *asperum*, with but a single relatively well-marked var. *asperum*, this confined to the Great Plains Region of the central U.S.A., and subsp. *capitatum* of the higher, more western regions, the latter having an array of varietal names, the earliest being var. *elatum*, first proposed by Torrey in 1858. To accommodate the nomenclature of this overview, the following names are proposed: **E. asperum** subsp. **capitatum** (Douglas) B.L. Turner, **comb. and stat. nov.**, and **E. a. var. lompocense** (Rossbach) B.L. Turner, **comb. nov.**

KEY WORDS: Brassicaceae, *Erysimum*, *E. asperum*, *E. capitatum*, California.

As noted by Al-Shehbaz (1988) and Rollins (1993), *Erysimum* is a genus of about 200 species largely confined to the Northern Hemisphere. Most of its species are confined to Eastern Europe and southwestern Asia. Rollins recognized 17 species as native to North America, these largely confined to the western United States. He also provided a tortuous key to the American taxa, based upon considerable herbarium and field experience. Among American species, the most difficult taxa belong to the *Erysimum asperum*-*E. capitatum* complex of the western United States, which is the subject of the present contribution.

In his treatment of the complex, Rollins recognized both *E. asperum* and *E. capitatum*, distinguishing between these in his key lead 10/10, as follows:

10. Siliques rigidly spreading nearly at right angles to the rachis, tetragonal; valves strongly ribbed, densely pubescent between the ribs and sparsely pubescent on the ribs giving a striped appearance.....**E. asperum**
10. Siliques divaricately ascending to erect; valves not strongly ribbed, more or less evenly pubescent, not markedly striped.....**E. capitatum** et al.

The principal distinction between the two taxa is clearly that of silique divergence, which in mature fruiting material is readily seen. In my opinion, other than divergence, the valve distinctions called to the fore by Rollins are exceedingly arbitrary. At least these are not readily apparent in the large number of pressed specimens I have examined.

Nevertheless, *E. asperum* (the earliest name for the duo), does exist as a well defined morphogeographical entity of the Great Plains of the central United States (Figs. 1, 2), readily recognized by its smaller habit, spreading siliques, and confinement to grassland habitats. Westwards and/or upslope, *E. asperum* grades into the largely allopatric *E. capitatum*, either as a result of extant or near extant hybridization (secondary intergradation) and/or ancestral in situ divergence (primary intergradation) of the two taxa concerned. Intergradation of the latter type (allopatric introgression) is usually much more gradual and more difficult to detect than the former (sympatric hybridization), as well noted by Anderson (1953).

Weber (1990) noted that both *E. asperum* and *E. capitatum* occur in Colorado and that the former hybridizes with the latter "along the base of the foothills." He further notes that *E. capitatum* has "siliques green and almost glabrous, ascending, usually nearly parallel to the stem, although the pedicels may spread widely." He also added that *E. capitatum* is "very common and extremely variable."

Indeed, intergrades between the two taxa can be found (or inferred) throughout the region of allopatric and/or sympatric contact, this often

perceived in populations relatively remote from regions of immediate contact, suggesting long-term introgression, this supporting the view that the intergradation is of a primary nature.

Regardless, numerous floristic workers have been confounded by the two taxa, some treating these as but a single widespread variable species (e.g., Davis 1952; Hitchcock and Cronquist 1973; Harrington 1979 [who noted that *E. asperum* included elements of the *E. capitatum* complex and that its siliques may be "ascending or rarely divaricate."]; Walsh et al. 1987; Albee et al. 1988; Scott 1995 [who recognized but a single species, *E. asperum*, under this listing 22 specific names in synonymy, this perhaps unrivaled among any other plant species of the western U.S.A.]).

Even within the boundaries of California Hoover (1970), in his discussion of *E. capitatum*, *E. moniliforme* and *E. occidentale*, noted that "Herbarium specimens of both *E. occidentale* and *E. asperum* can be found which differ from individuals of *E. moniliforme* in no outwardly visible way. I suspect that, after adequate studies of the plants in all their habitats and in cultivation, these plants will ultimately be included in *E. asperum*."

Nevertheless, Price (1993), in his treatment of Californian *Erysimum* for the Jepson Manual, excluded *E. asperum* from that state, but he did recognize *E. capitatum* (albeit with at least 4 subspecies, and yet other specific segregates such as *E. franciscanum*, *E. suffrutescens*, and *E. insulare*).

Reveal (1972) summed up the controversy over the competing names thusly:

Erysimum asperum is a widespread and highly variable species that is composed of several weakly defined varieties. The type of the species comes from the Great Plains and has more or less spreading fruits. The western United States material with yellow flowers and erect fruits should be called var. *purshii*. Hitchcock (1964) was unable to determine which name should be applied to this phase, being unaware of Durand's publication. In most western floras, this phase has been called *E. capitatum* (Doug. ex

Hook.) Greene, although Welsh et al. (1965) call this plant simply *E. asperum*.

Those specimens with orangish or reddish flowers from the southern Rocky Mountains and high mountains of Utah should be called *E. asperum* var. *amoenum* (Greene) Reveal, comb. & stat. nov., based on *Cheiranthus nivalis* var. *amoenus* Greene, Pittonia 3: 137. 1896. Holmgren (1959) and Welsh et al. (1965) have called this phase *E. wheeleri* Rothr. Similar plants occur sporadically in the Pacific Northwest but appear to represent another kind as yet undescribed (Hitchcock 1964), while those of the southern Coast Range of California are called *E. asperum* var. *stellatum* J. T. Howell.

Reveal briefly outlined the nomenclatural consequences of a widespread highly variable *E. asperum* (including *E. capitatum*, this relegated to synonymy under *E. asperum* var. *purshii*), he apparently was unaware of the earlier varietal name, *E. asperum* var. *elatum* (Nutt. ex Torr. & Gray) Torr., a combination first published in 1858 (2 years before *E. asperum* var. *purshii*). The type of *E. a.* var. *elatum* (= *E. elatum* Nutt.) is from northwestern Oregon, reportedly from along the Wahlamet (= Willamet) River, first collected by Nuttall himself. Rollins (1993) included this variety within his concept of *E. capitatum* var. *capitatum*. Clearly though, if *E. capitatum* is treated within an expanded *E. asperum*, such as I do for the state of Texas, the earliest legitimate varietal name for the *E. capitatum* complex (sensu lato) is *E. asperum* var. *elatum*.

My taxonomic account of the *E. asperum*-*E. capitatum* complex can be summarized as follows:

Erysimum asperum comprises two subspecies: 1.) subsp. *asperum*, which is composed of a single, more or less well defined var. *asperum*, largely confined to the prairie lands of the central U.S.A.; and 2.) subsp. *capitatum*, which is largely confined to the more montane regions of the western U.S.A., Canada, and Mexico, although occasional populations occur in the more forested regions of the eastern U.S.A., where perhaps introduced. Within the subsp. *capitatum* numerous forms and populations exist, some seemingly worthy of varietal recognition as espoused by the criteria of Turner and Nesom (2000).

Price (1993), in his treatment of the genus *Erysimum* for California, did not recognize *E. asperum*, but instead, treated all of the taxa relating to this as *E. capitatum*. Within the latter he recognized four subspecies, as follows: 1.) subsp. **angustatum** (E. Greene) R.A. Price [= *E. capitatum* var. *angustatum* (E. Greene) Rossbach]; 2.) a typical *E. c.* subsp. **capitatum** [including *E. asperum* var. *stellatum* J. Howell, *E. capitatum* var. *bealianum* (Jeps.) Rossbach, *E. argillosum* (E. Greene) Rydb., and *E. moniliforme* Eastw.]; 3.) subsp. **lompocense** (Rossbach) R.A. Price [= *E. capitatum* var. *lompocense* (Rossbach) Kartez = *E. suffrutescens* (Abrams) Rossbach var. *lompocense*]; and 4.) subsp. **perenne** (Cov.) R.A. Price [= *E. perenne* Coville) Abrams; and *E. capitatum* var. *perenne* (S. Wats. ex Cov.) R.J. Davis]. Unfortunately, as of this writing none of the aforementioned subspecies has been formalized.

Price noted that the four subspecies (or varieties) intergrade locally with peripheral subspecies, including also *E. insulare* ssp. *suffrutescens*. This being so, I am inclined to recognize the taxa concerned as varieties within the larger subspecific category, *capitatum* of *Erysimum asperum*. The formal nomenclature for the Californian taxa follows:

***Erysimum asperum* (Nutt.) DC., Syst. Veg. 2: 505. 1821. Based on**
Cheiranthus asperum Nutt., Gen. N. Amer. Pl. 2: 69. 1818.

Erysimum asperum* (Nutt.) DC. subsp. *asperum

Price (1993) proposed, but did not make formal, the rank of subsp. *capitatum* within his concept of *E. capitatum*.

***Erysimum asperum* subsp. *capitatum* (Douglas) B.L. Turner, **comb. & stat. nov.**, Based on *Cheiranthus capitatus* Douglas, in Hook. Fl Bor. Am. 1: 38. 1829.**

***Erysimum asperum* var. *angustatum* (Rydb.) B. Boivin,**
Phytologia 16: 298. 1968.

***Erysimum asperum* var. *elatum* (Nutt.) Torrey, Pacific Railroad Report 7, Pt. 3. 1858. This is the earliest varietal name within the subsp. *capitatum*, having priority over *E. asperum* var.**

capitatum (Douglas ex Hook.) B. Boivin, Naturaliste Canad. 94: 646. 1972.

Erysimum asperum var. **lompocense** (Rossbach) B.L. Turner, **comb. nov.** Based upon *Erysimum suffrutescens* var. *lompocense* Rossbach, Aliso 4: 123. 1958.

Erysimum asperum var. **perenne** S. Watson ex Coville, Proc. Biol. Soc. Washington: 7: 70. 1892.

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I am grateful to Guy Nesom for reviewing the manuscript, and for his helpful comments. Figures 1 and 2 are compiled from the distribution of *E. asperum* as shown in the Atlas of the Flora of the Great Plains (1977: Iowa State Univ. Press) and specimens at LL, SRSC, and TEX; intermediates between the two taxa are not indicated in Fig. 2, but exist in the southern Panhandle region of Texas, as also noted by Rollins (1993).

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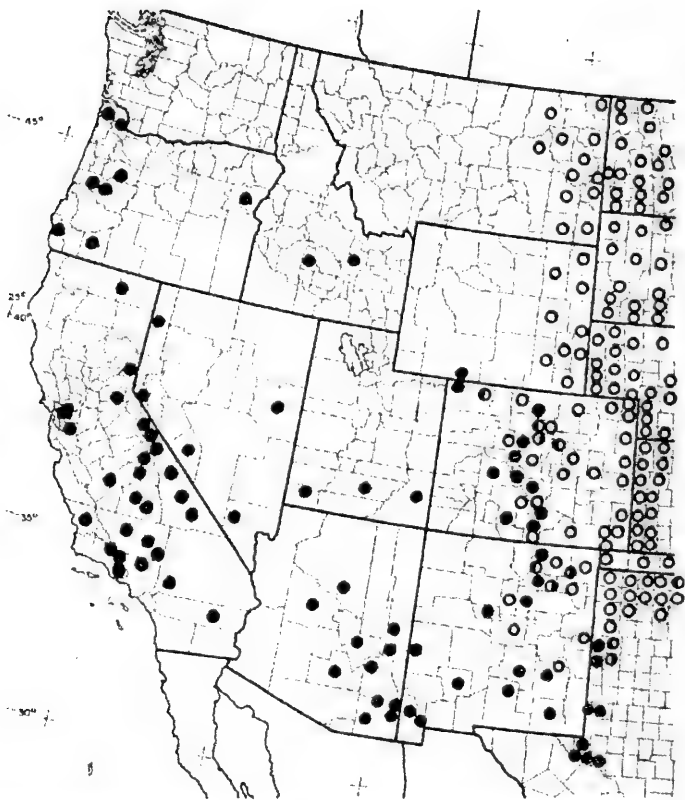


Fig. 1. Distribution of *Erysimum asperum* subsp. *asperum* (open circles); subsp. *elatum* (closed circles; Intermediates (half circle).

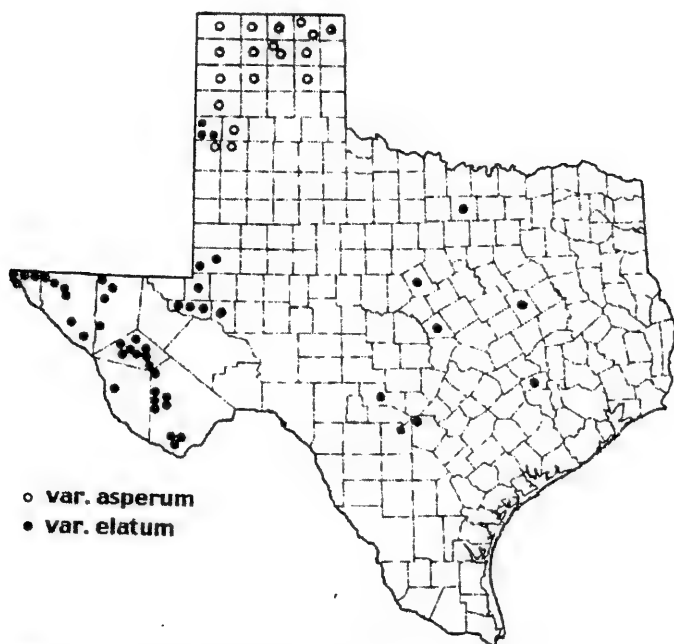


Fig. 2. *Erysimum asperum* (in Texas); Intermediates not shown.

**DALEA AUSTROTEXANA (FABACEAE), A NEW SPECIES
FROM SOUTHERNMOST TEXAS**

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ABSTRACT

Populations of *Dalea lantana* from southernmost Texas, previously placed within the fabric of *D. lanata* var. *lanata*, have been described as a new species, *D. austrotexana*. It occurs in only a few counties, where it is largely confined to dune sands. In addition, the var. *terminales* of *D. lanata* is recognized at the species level, where it must take the name *D. glaberrima* S. Wats. A key to the three taxa concerned is provided, along with maps showing their distribution.

KEY WORDS: *Dalea lanata*, Fabaceae, Texas

In his exceptionally honed treatment of *Dalea* and its cohorts, Barneby (1977) positioned *D. lanata* Spreng. as the sole member of his sect. *Elaspora*, subgenus *Dalea*, this largely defined by its peltate, cornet-shaped banner. He recognized two infraspecific taxa within the species, var. *lanata* and var. *terminalis* (M.E. Jones) Barneby. He also called attention to isolated populations in southernmost Texas which, in his opinion, "seem not to differ in any appreciable way [from var. *lanata*]." Turner et al. (2003) recognized *D. terminalis* at the specific level, but the correct at that rank is *D. glaberrima*.

In the present paper I have elevated both of his formal varieties to specific rank, and have described the afore-mentioned populations from southern Texas as new. Thus, as conceived by the present author, the previously monotypic sect. *Elaspora* now contains three allopatric species. The following key will readily identify the taxa concerned:

Key to the *Dalea lanata* complex:

1. Calyx tube glabrous (rarely not), the lobes deltoid.....
.....*Dalea glaberrima*
1. Calyx tube pubescent, the lobes lanceolate.....(2)
 2. Mature leaflets mostly 2.5-4.0 mm long; southernmost
Texas.....*Dalea austrotexana*
 2. Mature leaflets mostly 4.5-10.0 mm long; grasslands of the
central U.S.A.....*Dalea lanata*

In addition to the characters called to the fore in the above key, it should be noted that *D. austrotexana* has mostly smaller racemes and, paler petals with more markedly pustulate glands at their apices than does *D. lanata*.

***Dalea austrotexana* B.L. Turner, sp. nov.**

Dalea lanata Spreng. similis sed differrt foliolis costanter minoribus (2.5-4.0 mm vs 4.4-10.0 mm longis) et petalis minoribus pallidioribus ac pustulis glandulosis valde crescioribus.

Perennial prostrate herbs 0.3-0.5 m across, arising from lignescent orange tap roots. **Stems** villose. **Leaves** odd-pinnate, mostly 1-2 cm long, 0.5-1.5 cm wide, the leaflets obovate, mostly 3.0-4.5 mm long, pubescent like the stems. **Flowering spikes** mostly 3-5(7) cm long, 0.5-0.7 cm wide; peduncles mostly 1.0-1.5 cm long; bracts ovate, ca. 1.5 mm long, abruptly apiculate. **Calyx** villous, 3-4 mm long, the lobes lanceolate, ca. as long as the tube. **Petals** as described for *D. lanata* (by Barneby) but somewhat smaller, a paler purple, the banner ca. 4 mm long (blade ca. 2.1 mm long; stipe ca. 1 mm long), having well-developed terminal pustules. **Legume** ca. 2.5 mm long, densely villose; seeds ca. 2 mm long.

TYPE: U.S.A. TEXAS. Jim Hogg Co.: E side of F. M. 1017, "{3 roadmiles S of jct. With smaller road at Agua Nueva," ca. 450 ft, 26 51 38N, 98 36 46W, 7 Oct 1993, *W.R. Carr 13205* (Holotype: TEX).

ADDITIONAL COLLECTIONS EXAMINED(LL, TEX): Brooks Co.: E side of US 281, 3 mi S of F.M. 3066, 4 Jun 1998, *Carr 17524*; NE part of Encinitos Ranch, 14 Jun 2006, *Carr 24623*; 3.4 mi N of Encino, 9 Jul 1954, *Johnston 541201*. **Cameron Co.:** sand dunes, mouth of Rio

Grande, 13 Jul 1957, *Correll & Johnston* 17967; Brazos Island State Park, 13 Aug 1977, *Richardson* 2525; sand flats near mouth of Rio Grande, 18 Jun 1931, *Runyon* 1428; Brazos Santiago Island, 5 Sep 1938, *Runyon* 1945; sand dunes at Boca Chica, 7 Oct 1939, *Runyon* 2078. **Jim Hogg Co.:** 1.7 mi S of Agua Nueva, 9 Oct 1954, *Tharp & Johnston* 541859. **Kenedy Co.:** Norias Division of King Ranch, 18 Jun 1953, *Johnston s.n.* **Starr Co.:** ca. 2 mi NE of Santa Elena, 13 Sep 1955, *Johnston* 2777.

Nearly all of the above collections were reportedly obtained from loose sand on active or stabilized dunes, but a few were obtained from "sandy flats."

Dalea austrotexana is clearly more closely related to *D. lanata* than it is to *D. glaberrima*, as noted by both Barneby (1977) and Isely (1997). Thus, I might with equal validity have described it as but a variety of the former. But such recognition would ignore its morphological divergence and isolated geographic position, presumably a reflection of its relict confinement to the dune sands of southern Texas, following the movement of populations of *D. lanata* northwards after the most recent glacial retreats. Alternatively, these might reflect long distance dispersal events over the past 10,000 years or so. What is known, however, is that the populations concerned have diverged from their common grassland's ancestor, *D. lanata*, and were not derived from the more montane, upstream, populations of *D. glaberrima* from along the Rio Grande.

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I am grateful to my colleague and longtime friend, Guy Nesom, for the Latin diagnosis and helpful editorial suggestions.

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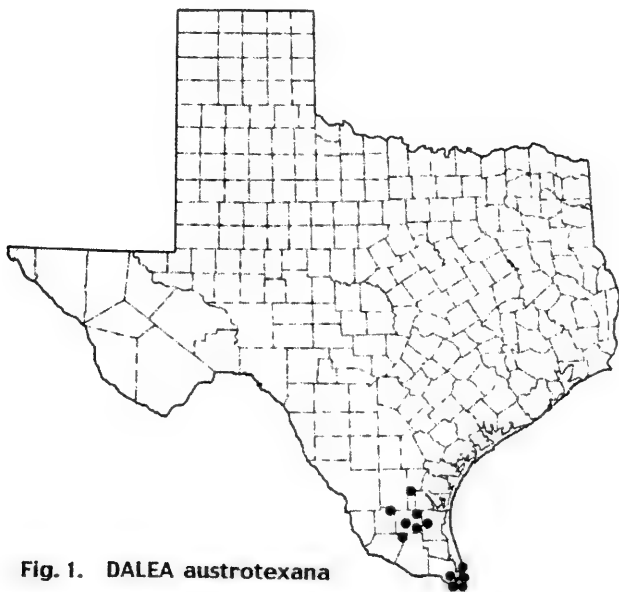


Fig. 1. *DALEA austrotexana*

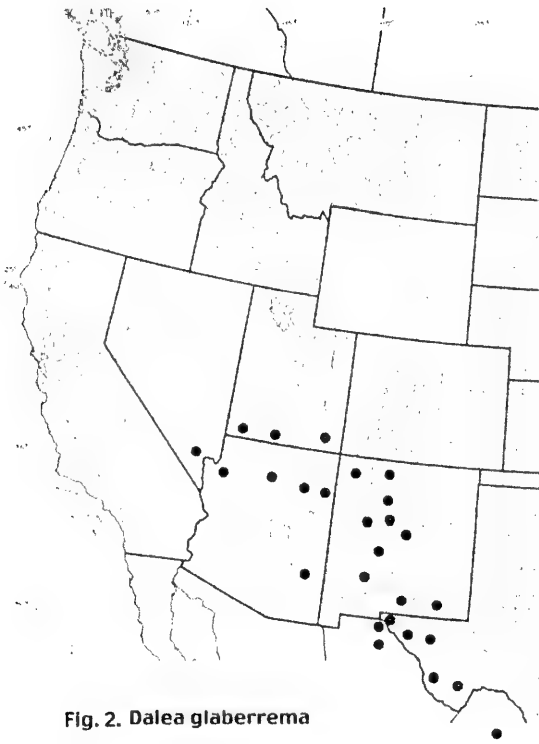


Fig. 2. *Dalea glaberrema*

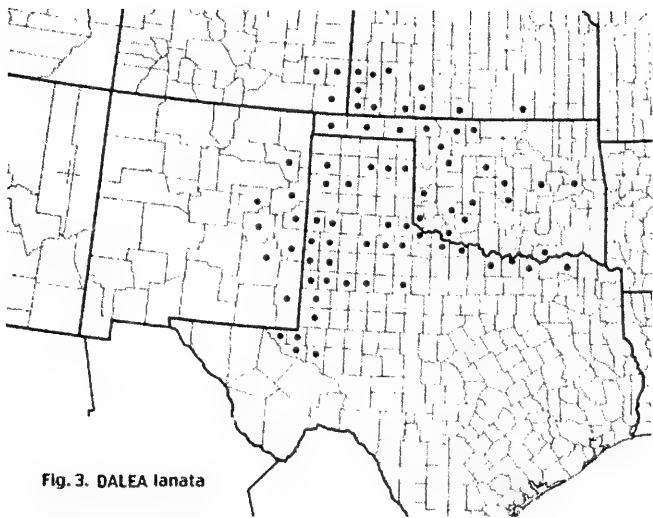


Fig. 3. *DALEA lanata*

A NEW VARIETY OF *DODECATHEON PULCHELLUM*
(PRIMULACEAE)

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ABSTRACT

Dodecatheon pulchellum var. *distolum* is proposed for a sparsely glandular or glandular-puberulent taxon from northeastern Wyoming and extreme west central South Dakota. It is most closely related to the more western, densely glandular-puberulent var. *cusickii* of British Columbia south to Oregon eastward across Idaho to western Montana and northwestern Wyoming.

KEY WORDS: *Dodecatheon*, *Primulaceae*, Flora of North America

While preparing a treatment of *Dodecatheon* L. (*Primulaceae*) for a forthcoming volume of *Flora of America*, the following undescribed variant of the widespread, western North American species, *D. pulchellum* (Raf.) Merr., was noted.

Dodecatheon pulchellum (Raf.) Merr. var. *distolum* Reveal, var. nov.
TYPE: UNITED STATES. Wyoming, Weston Co.: Black Hills, Black Hills National Forest, Thomson Canyon, about 8.5 air mi NE of Newcastle, in small opening of *Pinus ponderosa* on Paha Sapa limestone, 43°55'57", 104°03'33", T46N, R60W, sec. 33NENE, 5500 ft elev., 4 Jun 1984, H. Marriott 6448, holotype: RM.

A var. cusickii plantis parce minute glandulosis et glanduloso-puberulis differt.

Plants erect herbaceous perennials, 0.6–3.5(–4) dm tall, sparsely glandular-puberulent and often minutely glandular; *caudex* not obvious

at anthesis, the roots white, without bulblets; *leaves* basal, 2–10 (13) cm long, (0.3) 0.5–2 cm wide, decurrent to base or nearly so, the blades tapering gradually to a non-winged (at least basally) petiole, oblanceolate to elliptic, sparsely glandular-puberulent, the margins usually entire; *inflorescences* 1–10-flowered, the bracts lanceolate, 2–7 mm long, usually minutely glandular at least on margins, the pedicels 0.5–3.5 cm long at anthesis, sparsely and minutely glandular; *flowers* 5-merous, the calyx 4–8 (9) mm long, mostly green, glabrous or more often minutely glandular at least on margins, the tube 1.5–3 mm long, the lobes 3–6 mm, the reflected petals 0.8–1.5 (1.8) cm long, magenta to lavender or rarely white, tube yellow with a thin, wavy, reddish ring; *stamens* 5, the filaments fused into a tube 1–2 (2.5) mm long, yellow, smooth or more often longitudinally wrinkled, the anthers 3.5–6 mm, pollen sacs yellow, the connective maroon; *stigma* not enlarged; *capsule* cylindric-ovoid, 8–15 mm long, 3–5 mm wide, tan to light brown, often reddish-brown apically, glabrous, valvate.

Syncline shootingstar, var. *distolum* (*distolus* Gr., in pairs, as to the Big Horn Mountains and Black Hills at each end of a syncline that forms Powder River Basin of northeastern Wyoming), is found primarily on limestone gravel to rocky slopes and outcrops on the foothills and low to middle elevations of the Big Horn Mountains, the Black Hills, and around Devils Tower of northeastern Wyoming and west central South Dakota. The plant also occurs on sandstone or granite, and rarely on gypsum; it can be found at much higher elevations in the Big Horn Mountains. For the most part it is a plant of dry places on forest floors but occasionally will be found along streams or near the edges of moist meadows. It is associated primarily with ponderosa pine or with juniper, mountain mahogany, and sagebrush. Occasionally it is found with aspen or even birch. The variety occurs mainly from 3800 to 6400 feet, with some populations known from as high as 9100 feet. The var. *pulchellum* occurs on the Big Horn Mountains mostly above 7000 feet elevation; presently the two varieties have not been found growing in close proximity.

Dodecatheon pulchellum var. *distolum* is similar to var. *cusickii* (Greene) Reveal in that both are glandular, with var. *cusickii* densely so on scapes, pedicels and calyx, whereas the new variety is sparsely glandular with the calyx either glabrous or (more often) with the sparse glands scattered over the abaxial surface or confined just to the margins.

Both varieties tend to have glandular-puberulent leaves and yellow pollen sacs, and therefore differ from occasional populations in southeastern Alaska and adjacent Yukon of var. *pulchellum* with purple pollen sacs that have minute glands on the pedicels. The new variety is known from Big Horn, Crook, Johnson, Sheridan and Weston cos., Wyoming, and Custer, Lawrence and Pennington cos., South Dakota. The var. *cusickii* occurs well to the west being found from northeastern Oregon northward to southeastern British Columbia, hence eastward across central and northern Idaho to western Montana. A disjunct population occurs at Birdseye, Fremont County, Wyoming.

Other specimens examined (all at RM unless otherwise indicated):

UNITED STATES. **South Dakota**, Custer Co.: Black Hills, ridge E of Hill Canyon near Log Cabin, Jewel Cave National Monument, T4S, R2E, sec. 2, 5350 ft., 14 May 1985, *Marriott 9461*; Black Hills, Lithograph Canyon, Jewel Cave National Monument, 0.25 mi E of Porthole, T4S, R2E, sec 1, 5250 ft., 4 Jun 1985, *Marriott 9559*. Lawrence Co.: Black Hills, Custer Peak, T3N, R3E, 6250-6750 ft, 22 Jun 1953, *Gilly et al. 494*; Black Hills, 1 mi from Hardy Guard Station, 25 Jun 1927, *Hayward 1424*; Black Hills, Box Elder Creek at Benchmark, T3N, R4E, sec. 12, 5020 ft., 15 Jun 1950, *Taylor & Taylor 6966*. Pennington Co.: Black Hills, Needles Trail, Harney Peak, 8 Jul 1927, *Hayward 1935*; foothills near Rapid City, 11 May 1924, *McIntosh 45*; Black Hills, Castle Creek Valley, 1 mi W of Deerfield, 26 Jun 1925, *McIntosh 691*; Black Hills, Black Elk Wilderness Area, 0.2 mi S of Horsethief Lake, T2S, R5E, sec. 11, 5100 ft., 22 May 2000, *Marriott & Mayer 11819*; Black Hills, Reynolds Prairie, T1N, R2E, sec. 13, 6200 ft., 25 May 1956, *Pase 491* (USFS); Black Hills, Tepee Gulch, T1S, R6E, sec. 34, 5000 ft., 26 May 1964, *Thilenius 66* (USFS); Black Hills, Harney Peak, 30 Jun 1911, *Visher 1608*. **Wyoming**, Big Horn Co.: Big Horn Mountains, Cottonwood Canyon, T56N, R93W, sec. 33, 6300 ft., 13 Jul 1979, *B. E. Nelson 5283*; Big Horn Mountains, mouth of Dry Medicine Lodge Canyon and ridge above Medicine Lodge Canyon, T50N, R89W, sec. 9, 5000 5700 ft., 26 May 1980, *Dueholm & Hartman 9497*; Big Horn Mountains, Medicine Lodge Canyon, along Cold Springs Road, ca 8 air mi NE of Hyattville, T50N, R89W, sec. 1, 6400 ft., 26 May 1980, *Dueholm & Hartman 9516*. Crook Co., Black Hills, Sundance, May 1915, *P. Bowman s.n.*; Devils Tower National

Monument, Devils Tower, May 1934, *Giles* 36; Black Hills, South Fork of Reuter Canyon, ca 2 mi N of Sundance, 5700 ft, T52N, R63W, sec. 2, 13 Jun 1996, *Kass* 4573 (BRY, RM); ; Devils Tower National Monument, along a fire trail N of Devils Tower, T53N, R65W, sec. 7, 4250 ft., 29 Apr 1981, *Marriott* 623; Black Hills, Bear Lodge Mountains, Black Hills, E of Bear Lodge Campground, T54N, R62W, sec. 20, 4600 ft., 20 May 1983, *Marriott* 2134; Black Hills, draw between Burnt Hollow and Sourdough creeks near Belle Fourche River, T55N, R64W, sec. 20, 3800 ft elev., 23 May 1983, *H. Marriott* 2181; Black Hills, Bear Lodge Mountains, Bear Lodge Mountains, East Fork of Blacktail Creek, ca 9.4 air mi SE of Hulett, T53N, R64W, sec. 13 and T53N, R63W, sec. 18, 4700 ft., 24 May 1983, *Marriott* 2308; Black Hills, Bear Lodge Mountains, N and W of Reuter Campground, T51N, R63W, sec. 4, 5600 ft, 27 May 1983, *Marriott* 2314; Black Hills, Snider Ranch, upper Corral Creek drainage, T51N, R65W, sec. 10, 4600 ft., 27 May 1983, *Marriott* 2365; Black Hills, Redwater Creek, Queen Ranch, T53N, R62W, sec. 25, 4100 ft., 31 May 1983, *Marriott* 2535; Black Hills, Medicine Lake, T51N R62W S4, 4500 ft., 1 Jun 1983, *Marriott* 2567; Black Hills, Government Valley, T52N, R62W, sec. 5, 4600 ft., 6 Jun 1983, *Marriott* 2591; Sundance Mountain, T51N, R63W, sec. 24, 5300 ft., 28 May 1984, *Marriott* 6400; Black Hills, Inyan Kara Creek drainage off Norris Divide, T49N, R64W, sec. 5, 4400 ft., 7 Jun 1984, *Marriott* 6608; Black Hills, Hain Spring, off Lost Canyon, T49N, R60W, sec. 29, 6300 ft., 12 Jun 1984, *Marriott* 6655; Black Hills, Sand Creek above Spottedtail Gulch, T51N, R60W, sec. 21, 5300 ft., 16 Jun 1984, *Marriott* 6811; Black Hills, Inyan Kara Mountain, T49N, R62W, sec. 19, 5400 ft., 19 Jun 1984, *Marriott* 6869; Black Hills, 7 mi NW of Hulett, 4500 ft, 24 May 1935, *M. Ownbey* 576; Black Hills, Reuters Canyon, 5 mi N of Sundance, 5500, 21 Jun 1950, *C. L. Porter* 5361. Johnson Co.: Powder River Basin, about 10 air mi NNW of Buffalo, T53N, R82W, sec. 31, 4700 ft., 1 Jun 1979, *Dueholm* 6273; Powder River Basin, about 7 air mi SE of Sheridan, T55N, R83W, sec. 23, 4600 ft., 9 Jun 1979, *Dueholm* 6841; Big Horn Mountains, Snow Cave Ridge, T45N, R84W, sec. 21, 8000 ft., 28 Jun 1979, *Hartman* 9786; Big Horn Mountains, Elgin Park, T49N, R83W, sec. 5, 7800 ft., 8 Jun 1980, *B. E. Nelson* 5235b; Big Horn Mountains, rim above Beartrap Meadows, T46N, R84W, sec. 31, 8100 ft elev., 9 Jun 1980, *B. E. Nelson* 5246; Big Horn Mountains, just E of Munkres Pass at the headwaters of Muddy Creek, T48N, R85W, sec. 11, 9400 ft., 8 Jul 1980, *B. E. Nelson* 5996;

Big Horn Mountains, along Merle Creek, S of Sheep Mountain, T49N, R84W, sec. 30, 9000 ft., 10 Jul 1980, *B. E. Nelson 6104*. Sheridan Co.: Big Horn Mountains, about 1 air mi NW of Freeze Out Point, T57N, R88W, sec. 35, 8000 ft elev., 15 Jul 1979, *Hartman 10185*. Washakie Co.: Big Horn Mountains, Rome Hill Road, T46N, R86W, sec. 9, 7200 ft., 27 May 1980, *Dueholm & Hartman 9587*; Big Horn Mountains, Big Trails Stock Trail along Crooked Creek, T44N, R86W, sec. 30, 6600 ft., 22 May 1980, *Hartman & Dueholm 10981*; Big Horn Mountains, Rome Hill, T46N, R86W, sec. 6, 6000 ft., 27 May 1980, *Hartman & Dueholm 11270*; Big Horn Mountains, along old U.S. Hwy 16 in Tensleep Canyon, T48N, R87W, sec. 24, 7300 ft., 16 Jun 1980, *B. E. Nelson 7355*. Weston Co.: Black Hills, along U.S. Hwy 16 W of state line, T44N, R60W, sec. 27, 4450 ft., 16 May 1984, *Marriott 6140*; Black Hills, headwaters of Oil Creek just N of Skull Creek Road, T48N, R61W, sec. 19, 5400 ft elev., 22 May 1984, *Marriott 6185*; Black Hills, W of Wyoming Hwy 116, T48N, R65W, sec. 12, 4600 ft., 25 May 1984, *Marriott 6274*; Black Hills, Cambria Creek drainage NE of Cambria site, T46N, R61W, sec. 20, 4700 ft., 12 Jun 1984, *Marriott 6734*; Black Hills, Stockade Beaver Creek E of Mallo Camp, T47N, R60W, sec. 3, 6200 ft., 13 Jun 1984, *Marriott, 6767*; Black Hills, Black Buttes, on an unnamed butte E of Iron Mountain, T50N, R62W, sec. 26, 5700 ft, 21 Jun 1984, *Marriott 6946*; Black Hills, west side of ridge S of Elk Mountain (USFS Road 818) near Mix Spring, T43N, R60W, sec. 21, 4800 ft., 26 Jun 1984, *Marriott 7160*; Black Hills, Bearlodge Mountains, Bearlodge Campground near Wyoming Hwy 24, T54N, R62W, sec. 20, 4600 ft., 21 May 1989, *Marriott 10944*; Black Hills, Dugout Gulch, T52N, R60W, sec. 19, 4000 ft., 23 May 1989, *Marriott 10977*.

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RE-EXAMINATION OF THE TAXONOMY OF THE ONE-
SEEDED, SERRATE LEAF *JUNIPERUS* OF SOUTHWESTERN
UNITED STATES AND NORTHERN MEXICO
(CUPRESSACEAE)

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ABSTRACT

The one-seeded, serrate leaf margined junipers of Southwestern United States and northern Mexico consist of *J. angosturana*, *J. californica*, *J. coahuilensis* var. *arizonica*, *J. c.* var. *coahuilensis*, *J. monosperma*, *J. pinchotii*, *J. occidentalis* var. *australis*, *J. o.* var. *occidentalis* and *J. osteosperma*. Recent nrDNA and trnC-trnD sequence data were compared with RAPDs analysis and two of the taxa (*J. c.* var. *arizonica*; *J. o.* var. *australis*) were found to be in separate clades. In addition, the two taxa were as distinct as other recognized species in the group. Because of this, *Juniperus coahuilensis* var. *arizonica* is recognized at the specific level as *J. arizonica*. Since the specific name *J. australis* is unavailable due to prior use, *J. occidentalis* var. *australis*, was given a new name, *J. grandis*, to denote the robust tree nature of the big western juniper. All the remaining taxa were quite distinct in both their sequences and RAPDs data.

KEY WORDS: *Juniperus*, *J. angosturana*, *J. californica*, *J. arizonica* (= *J. coahuilensis* var. *arizonica*), *J. coahuilensis*, *J. monosperma*, *J. pinchotii*, *J. grandis* (= *J. occidentalis* var. *australis*), *J. occidentalis*, *J. osteosperma*, RAPDs, nrDNA, trn C-trnD, Cupressaceae

The one-seeded, serrate leaf margined *Juniperus* of Southwestern United States and northern Mexico are *J. angosturana*, *J. californica*, *J. coahuilensis* var. *arizonica*, *J. c.* var. *coahuilensis*, *J. monosperma*, *J. pinchotii*, *J. occidentalis* var. *australis*, *J. o.* var. *occidentalis* and *J. osteosperma* (Adams, 2004). Previous studies using morphology and terpenoids failed to clearly arrange the taxa into groups (Zanoni and Adams, 1976, 1979). However, recently DNA sequencing of nrDNA and trnC-trnD (Schwarzbach, et al., 2007) has shed new light on the relationships within this group. Firstly, the one-seeded, serrate leaf margined junipers were found to be paraphyletic. Secondly, *J. californica* was shown to be quite distinct (Fig. 1), however, analysis of nrDNA and trnC-trnD sequence data individually gives weak support that *J. californica* is sister to the *J. occidentalis* - *J. osteosperma* clade, and additional research will be needed to resolve this issue. A third aspect is that the remaining all are divided into two large clades (Fig. 1). One clade consists of *J. angosturana*, *J. coahuilensis* var. *coahuilensis*, *J. monosperma*, and *J. pinchotii*, taxa from the Chihuahuan desert margins. The second clade is composed of *J. coahuilensis* var. *arizonica*, *J. occidentalis* var. *australis*, *J. o.* var. *occidentalis*, and *J. osteosperma* is from the Sonoran, high Utah-Nevada, Mojave deserts, and Sierra Nevada. The sequence data revealed two taxonomic problems: *Juniperus coahuilensis* var. *coahuilensis* and *J. c.* var. *arizonica* are well supported as members of different clades (Fig. 1) and *J. occidentalis* var. *australis* is 100% supported as being more closely related to *J. osteosperma* than to *J. o.* var. *occidentalis* (Fig. 1). Both of these taxa have evolved independently and are an additional case of cryptic speciation within the genus *Juniperus*. Cryptic speciation has also been found between *Juniperus deltoides* and *J. oxycedrus* in the Mediterranean region (Adams et al. 2004) and between *J. erectopatens* and *J. sabina* in China (Adams, 2004).

To further investigate this problem, DNA fingerprint analyses were performed for the same taxa. RAPDs (Random Amplified Polymorphic DNAs) is a form of DNA fingerprinting that has been used

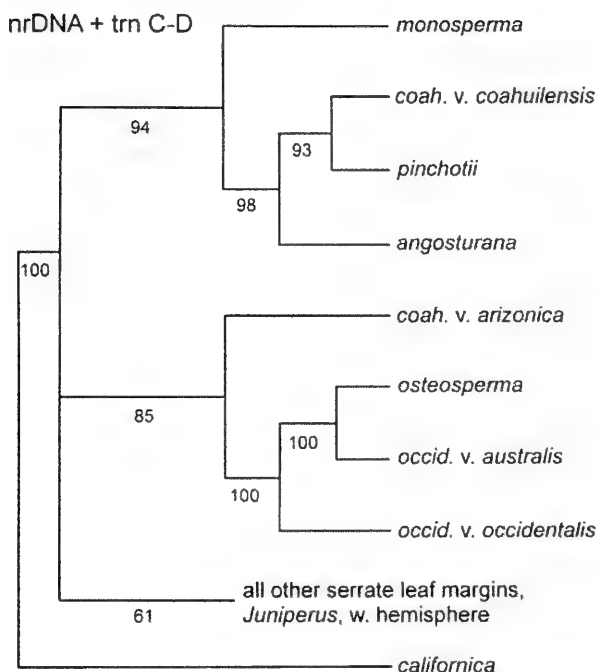


Figure 1. Partial phylogenetic tree derived from nrDNA + trnC-D sequence data (adapted from Schwarzbach et al., 2007). Values below branches are posterior probabilities.

in several *Juniperus* studies and has proved useful in systematics generally (Adams, 1999, 2000a-d; Adams and Demeke, 1993; Adams and Nguyen, 2005), when stringent laboratory procedures are followed (Adams, Flournoy and Pandey, 1998). In this study, we report on RAPDs analysis and combine these results with the DNA sequence data and morphology to evaluate the taxonomic status of *J. coahuilensis* var. *arizonica* and *J. occidentalis* var. *australis*.

MATERIALS AND METHODS

Specimens collected: *J. angosturana*, Adams 6881-25, 12.7 km e of Villa Juarez, San Luis Potosi, Mexico; *J. californica*, Adams 8695-7, 13

km n of Amboy/Kelso I40 exit on the road to Kelso, CA; *J. coahuilensis* var. *arizonica*, Adams 10634-36, on AZ hwy 179 between I17 and Sedona, AZ; *J. c.* var. *coahuilensis*, Adams 6829-31, on Mex. hwy. 45, 85 km n of La Zarca, Durango, Mexico; *J. monosperma*, Adams 7638-40, on I40, Santa Rosa, NM; *J. pinchotii*, Adams 7483-87, 5 km w of Ozona, TX on US 290; *J. occidentalis* var. *australis*, Adams 8692-94, n side of L. Baldwin, San Bernardino Mtns., CA; *J. o.* var. *occidentalis*, Adams 8592-94, 0.2 km nw of Sisters, OR; *J. osteosperma*, Adams 6811-13, Little Cottonwood Canyon, Salt Lake City, UT. Voucher specimens are deposited at BAYLU.

One gram (fresh weight) of the foliage was placed in 20 g of activated silica gel and transported to the lab, thence stored at -20° C until the DNA was extracted. DNA was extracted using the Qiagen DNeasy mini kit (Qiagen Inc., Valencia, CA). The RAPD analyses follow that of Adams and Demeke (1993). Ten-mer primers were purchased from the University of British Colombia (5'-3'): 134, AAC ACA CGA G; 153, GAG TCA CGA G; 184, CAA ACG GAC C; 212, GCT GCG TGA C; 218, CTC AGC CCA G; 239, CTG AAG CGG A; 249, GCA TCT ACC G; 250, CGA CAG TCC C; 268, AGG CCG CTT A; 338, CTG TGG CGG T; 346, TAG GCG AAC G; 347, TTG CTT GGC G; 478, CGA GCT GGT C.

PCR stock solutions (Taq, primer, and buffer) were made in bulk so that all the PCR reaction tubes for a primer were prepared using the same bulk stock. This is a critical factor for minimizing variation in band intensities from sample to sample (see Adams, Flournoy and Pandey, 1998, for protocols to minimize PCR band variation). PCR was performed in a volume of 15 µl containing 50 mM KCl, 10 mM Tris-HCl (pH 9), 2.0 mM MgCl₂, and 0.1% Triton X-100, 0.2 mM of each dNTPs, 0.36 µM primers, 0.3 ng genomic DNA, 15 ng BSA and 0.6 unit of Taq DNA polymerase (Promega). A negative control PCR tube containing all components, but no genomic DNA, was run with each primer to check for contamination. DNA amplification was performed in an MJ Programmable Thermal Cycler (MJ Research, Inc.). Samples were run in duplicate to insure reproducibility (Adams, Flournoy and Pandey, 1998). A temperature profile was obtained for each well of the thermocycler to be sure that no variation existed among wells in the heating/ cooling block. The thermal cycle used was: 94° C (1.5 min) for initial strand separation, then 40 cycles of 40° C (2 min),

72° C (2 min), 91° C (1 min). Two additional steps were used: 40° C (2 min) and 72° C (5 min) for final extension. The temperature inside a PCR tube containing 15 µl buffer was monitored with a temperature probe, quantitated and printed for each step for each of the 40 cycles for every PCR run (Adams, Flournoy and Pandey, 1998) to insure that each cycle met temperature specifications and that each PCR run was exactly the same. Amplification products were analyzed by electrophoresis on 1.5% agarose gels, 75V, 55 min, and detected by staining with ethidium bromide. The gels were photographed over UV light using Polaroid film 667 and scanned to digital images. The digital images were size normalized in reference to pGem® DNA size markers before band scoring. Bands were scored as present (1) and absent (0). Bands that were inconsistent in replicate analyses were not scored.

Associational measures were computed using absolute character state differences (Manhattan metric), divided by the maximum observed value for that character over all taxa (= Gower metric, Gower, 1971; Adams, 1975). Principal coordinate analysis (PCO) was performed by factoring the associational matrix using the formulation of Gower (1966) and Veldman (1967). It should be noted that problems of homology of RAPD DNA bands on agarose gels can be significant (Rieseberg, 1996), but these errors can be accounted for using multivariate statistical methods (PCO) (see Adams and Rieseberg, 1998). A minimum spanning diagram was constructed by selecting the nearest neighbor for each taxon from the pair-wise similarity matrix, then connecting those nearest neighbors as nodes in a network (Adams, et al. 2003).

RESULTS AND DISCUSSION

The minimum spanning network based on RAPDs data (Fig. 2) is very similar to the nrDNA + trnC-trnD sequence tree (Fig. 1). As with the sequence data, *J. californica* is shown to be very distinct. However, *J. monosperma* is depicted as more distinct (Fig. 2) than with the sequence data (Fig. 1). *Juniperus occidentalis* var. *australis* links with *J. osteosperma* rather than *J. o.* var. *occidentalis* (Fig. 2) just as seen in the sequence data (Fig. 1). These three taxa are difficult to distinguish. *Juniperus osteosperma* is the most xeric of the three, has the largest branchlets and the least apparent oil glands that seldom rupture, whereas *J. occidentalis* var. *occidentalis* is the most mesic, has the

smallest branchlets and very noticeable, ruptured leaf oil glands. *Juniperus occidentalis* var. *australis* is more or less intermediate in its

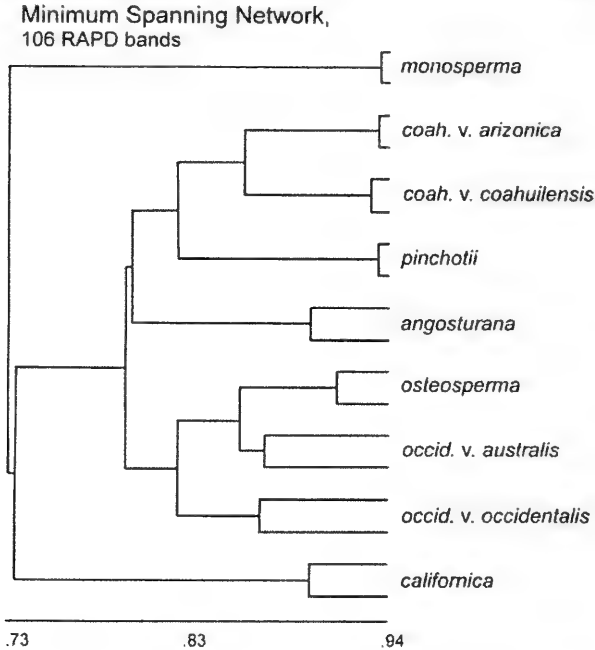


Figure 2. Minimum spanning network based on 106 RAPD bands. Notice that *J. coahuilensis* var. *arizonica* links loosely with *J. c.* var. *coahuilensis*, while *J. occidentalis* var. *occidentalis* is linked with *J. osteosperma*, rather than with *J. o.* var. *occidentalis*.

morphology and habitat. Vasek (1966) concluded that hybridization was occurring in northwestern Nevada between *J. osteosperma* and both *J. occidentalis* varieties. Terry et al. (2000), using nrDNA and cpDNA data, came to the same conclusion.

Multivariate ordination of RAPD data is valuable to complement minimum spanning networks. In order to concentrate on the two clades with taxonomic problems, *J. californica* and *J. monosperma* were removed from the RAPD data set and a PCO analysis was conducted. Factoring the similarity matrix yielded 9 eigenroots that appeared to

asymptote after the sixth eigenroot. These six eigenroots accounted for 80.06% of the variance among the taxa (30.0, 12.0, 11.7, 11.3, 8.6 and 6.5%). Ordination using the first 3 axes (Fig. 3) separates the clades on axis 1 (30%). Axes 2 and 3 separate *J. occidentalis* var. *occidentalis*,

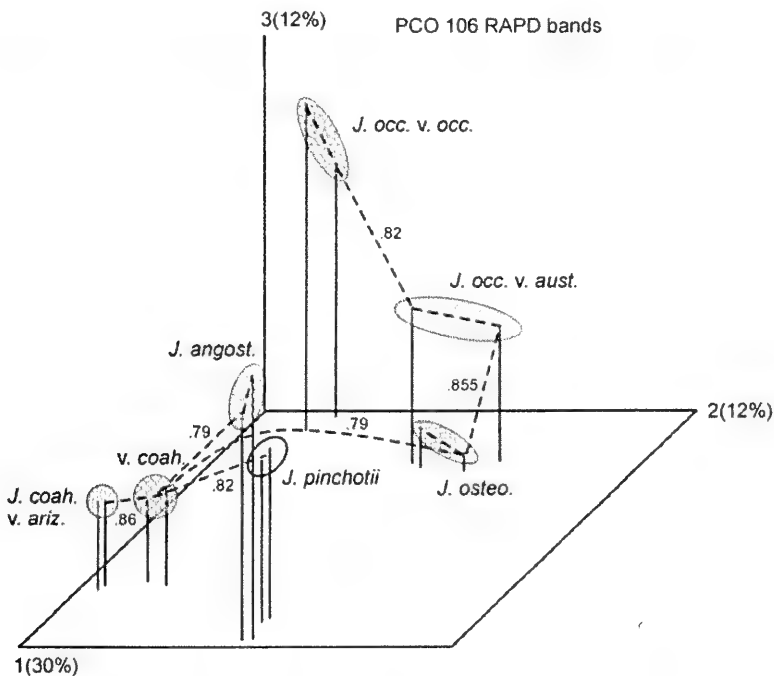


Figure 3. PCO of taxa based on 106 RAPD bands. Note the intermediate, but distinct position of *J. o.* var. *australis* between *J. o.* var. *occidentalis* and *J. osteosperma*.

J. o. var. *australis* and *J. osteosperma*, and to a lesser extent *J. coahuilensis* var. *coahuilensis* from *J. c.* var. *arizonica*. It should be noted that axes 4 and 5 separate *J. angosturana* from *J. pinchotii* and *J. c.* var. *coahuilensis* from *J. c.* var. *arizonica*.

Neither the sequence nor the RAPD data show that *J. occidentalis* var. *australis* and *J. o.* var. *occidentalis* form a monophyletic group. Vasek (1966) struggled with the appropriate taxonomic level for *J. o.*

var. *australis*. Morphologically, *J. californica*, *J. o.* var. *occidentalis*, *J. o.* var. *australis*, and *J. osteosperma* are very similar. They do, however, differ in their essential oils (Adams, 2004). Based on these new DNA data, it is deemed appropriate to recognize *J. occidentalis* var. *australis* at the specific level. Unfortunately, there exists and earlier *Juniperus australis* (Endl.) Pilg., in Urban, Aymb. Antill. 7: 479. 1913, which according to Farjon (2005) is synonymous with *Juniperus barbadensis* var. *lucayana* (Britton) R. P. Adams. Farjon (2005) designated a neotype for *J. australis* as *H. F. A. von Eggers 3586* (E), from Jamaica. Adams (2004) lists *J. australis* as a synonym under *J. lucayana* Britton. Regardless, *J. australis* is unavailable due to prior use, consequently new name is proposed:

***Juniperus grandis* R. P. Adams, nom. nov.**

Basionym: *Juniperus occidentalis* W. J. Hooker subsp. *australis* Vasek, Brittonia 18: 352 (1966), big western juniper, Type: United States, California, San Bernardino Mtns., CA, *Vasek 610929* (HOLOTYPE: RSA).

Distribution: California, w Nevada. See map, p. 140, Adams (2004).

Synonyms: *Juniperus occidentalis* var. *australis* (Vasek) A. & N.

Holmgren., Intermountain Fl. 1: 239 (1972).

The second taxonomic problem is presented by the placement of *J. coahuilensis* var. *coahuilensis* and *J. c.* var. *arizonica* in different clades (Fig. 1), coupled with the RAPDs data showing these taxa to be about as dissimilar as *J. osteosperma* and *J. occidentalis* var. *australis* (Fig. 2). Although the sequence and RAPDs data are not in complete agreement on this issue, taken together, they argue that the cryptic taxon *J. c.* var. *arizonica* is actually quite distinct and is an independent lineage that deserves recognition at the specific level as:

***Juniperus arizonica* (R. P. Adams) R. P. Adams, stat. nov.**

Basionym: *Juniperus coahuilensis* Martinez var. *arizonica* R. P. Adams, Biochem. Syst. Ecol. 22 (7): 708 (1994), Arizona juniper, Type: United States, Arizona, Yavapai Co.; 72 km s of Flagstaff, 1160 m, *R. P. Adams 2132* (HOLOTYPE: BAYLU!).

Distribution: Arizona, sw New Mexico, ne Sonora, MX, nw Chihuahua, MX. See map, p. 81, Adams (2004).

Synonyms: *J. erythrocarpa* Cory (in part: New Mexico, Arizona)

ACKNOWLEDGEMENTS

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**NEW VARIETAL COMBINATIONS WITHIN *STEPHANOMERA*
EXIGUA AND *S. VIRGATA* (ASTERACEAE)**

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Gottlieb (2006), in his treatment of *Stephanomeria exigua* for Fl. N. Amer., recognized 5 infraspecific taxa under this species, these recognized as subspecies: subsp. *carotifera* (Hoover) Gottlieb; subsp. *coronaria* (Greene) Gottlieb; subsp. *deanei* (J.F. Macbride) Gottlieb; subsp. *macrocarpa* Gottlieb; and the typical; subsp. *exigua*. He recognized no varietal taxa. However, three of these were treated as varieties by other workers. The following varietal names are proposed for the two taxa lacking such rank, this bringing the nomenclature into conformity with the views of Turner and Nesom (2000) and yet others:

***Stephanomeria exigua* var. *carotifera* (Hoover) B.L. Turner, stat. nov.**__ Based upon *Stephanomeria carotifera* Hoover, Leafl. W. Bot. 10: 252. 1966.

***Stephanomeria exigua* var. *macrocarpa* (Gottlieb) B.L. Turner, stat. nov.**__ Based upon *Stephanomeria exigua* subsp. *macrocarpa* Gottlieb, Madrono 21: 473. 1972.

It should be noted that Ford et al. (2006) found the typical subsp. *exigua* to form a clade consisting of the varieties *exigua*, *coronaria*, and *macrocarpa*. The subsp. *deanei* and subsp. *carotifera* are equivocal, perhaps more closely related to the *S. virgata* clade; unfortunately the subsp. *carotifera* was not accounted for in the DNA study concerned.

The only other species of *Stephanomeria* in which infraspecific taxa were recognized by Gottlieb is that of *S. virgata*, in which two subspecies were recognized: the typical subsp. *virgata*, and subsp. *pleurocarpa* (Greene) Gottlieb. The latter lacks a varietal combination, for which the following is proposed:

***Stephanomeria virgata* var. *pleurocarpa* (Greene) B.L. Turner, stat. nov.** Based upon *Stephanomeria pleurocarpa* Greene, Pittonia 2: 131. 1890.

Ford et al. (2006) discussed the cladistic relationships of *S. virgata* in more detail, but formal taxonomic proposals resulting from such studies are still in abeyance.

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TEXAS SPECIES OF *TRADESCANTIA* (COMMELINACEAE)**B. L. Turner**

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ABSTRACT

Tradescantia (including *Setcreasea*) is treated as having 13 species native to Texas. They are: *T. brevifolia*, *T. buckleyi*, *T. edwardsiana*, *T. gigantea*, *T. hirsutiflora*, (including *T. australis*), *T. humilis* (including *T. diffusa*, *T. eglandulosa* and *T. intermedia*), *T. leiandra*, *T. occidentalis* (including *T. vaginata*), *T. ohiensis* (including *T. difforme*), *T. pedicellata*, *T. reverchonii*, *T. subacaulis* (including *T. harbisonii*, and *T. texana*) and *T. wrightii*. An additional species, *T. crassifolia*, might also occur in Trans-Pecos (Chinati Mts.), but this needs confirmation. Keys to species, and comments regarding relationships and putative hybridization among them, are provided, along with distribution maps of the species concerned.

KEY WORDS: Commelinaceae, *Tradescantia*, *Setcreasea*, Texas.

Tradescantia is a notoriously difficult genus, especially in Texas where numerous taxa occur, many of these sympatric. Some workers have separated peripheral elements out of *Tradescantia*, giving these generic status (e.g. *Cuthbertia* Small, *Separotheca* Waterfall and *Setcreasea* K. Schum. & Sydow), but I follow the more inclusive treatment of Hunt (1975, 1980) in which 8 sections are recognized. The Texas species occupy two of these sections: Sec. *Setcreasea* (with 3 species), and Sec. *Tradescantia* (with 10 species).

MacRoberts (1980) has produced a perceptive study of *Tradescantia* for the state of Louisiana in which 6 species are recognized. He comments that the only general treatment of *Tradescantia* for the U.S.A. is that of Anderson and Woodson (1935) "...a work with serious drawbacks," and while "tacitly assumed to be

adequately treated by [these workers]... this is by no means true." He goes on to add the following:

Anderson and Woodson (1935) managed to bring a degree of order into the genus. However, the deficiencies of this monograph are increasingly evident. One of the shortcomings is the exiguous number of specimens cited, only about 1100 in all, including only 15 authorial citations, and failure to cite and document the field work referred to in Anderson (1954). The descriptions and diagnostics are often vague or unrepresentative, and the strong bias of the senior author concerning the frequency of hybridization resulted in attributing to the effects of hybridization what is probably no more than normal variation. Due to the extreme morphological variation in *Tradescantia*, collections must be fairly dense as well as widespread if the range of variation is to be perceived.

As regards Texas plants, I would agree, in general, with many of the remarks posited by MacRoberts. Field work is critical in one's attempt to evaluate populational variation, especially in *Tradescantia* where petals are deliquescent, habit and pubescence exceedingly variable, and where root systems play an important part in their classification, to say nothing of the (at least) occasional hybrid between this or that species, making identification (as to the recognition of reliable key characters) difficult.

Correll and Johnston (1970) have provided the most recent treatment of Texas *Tradescantias*. In this they recognize *Setreasea* (with 3 species) as distinct. Within *Tradescantia* they recognized 11 species (excluding *T. micrantha* Torr., which Hunt (1975), positions in the genus *Callisia*). While the key to species provided by Correll and Johnston is difficult, and if religiously followed leads to frequent "misidentifications," their treatment is basically sound, although largely adapted from Anderson and Woodson's (1935) paper. Indeed, in the treatment that follows I have recognized 10 of the taxa accepted by Correll and Johnston, reducing to synonymy only *T. tharpaii*, which appears to be, as annotated by Anderson and Woodson, a hodge-podge of variable plants of low stature largely assignable to either *T. hirsutiflora* or *T. subacaulis*. The most recent treatment of

Tradescantia for Texas is that of Faden (2000), this within his broad study of the genus for the North American Flora. Our treatments for Texas are essentially the same, except that I question the occurrence of *T. crassifolia* in Texas.

The following key will, I hope, provide a more reliable means by which to identify the Texas species, at least more so than the key provided by Correll and Johnston. Along with the distributional maps, identification should be facilitated, although the occasional hybrid or introgressed population may be difficult to label.

KEY TO TEXAS SPECIES OF *TRADESCANTIA*

1. Midstems glabrous or nearly so (rarely minutely hispid along upper internodes)(2)
1. Midstems clearly and persistently pubescent.....(9)
 2. Flowers more or less completely enclosed in the subtending spathes, the pedicels mostly 1-8 mm long(3)
 2. Flowers well-exserted from the subtending spathes.....(5)
3. Stiffly erect herbs with fascicles of enlarged fibrous roots; midstem leaves 8-10 times as long as wide.....*T. leiandra*
3. Sprawling succulent trailing or weakly ascending herbs with slender roots, often rooting at lower nodes; midstem leaves 3-6 times as long as wide(4)
 4. Leaves pallid or pale green, those at midstem mostly 1.5-2.0 cm wide; ovary pubescent at apex; trans-Pecos Texas.*T. brevifolia*
 4. Leaves dark green to purplish, those at midstem mostly 2-3 cm wide; ovary glabrous; southern Texas.....*T. buckleyi*
5. Sepals pubescent throughout or nearly so (rarely not in nearly glabrous forms of *T. occidentalis* in trans-Pecos).....(7)
5. Sepals glabrous throughout or with only a tuft of long hairs at the apices
 6. Delicate, simple-stemmed plants 10-20 cm high; leaves mostly basal or subbasal (rarely not), at midsection mostly 2-6 mm wide; trans-Pecos.....*T. wrightii*
 6. Relatively robust plants, mostly 20-100 cm high; leaves rather evenly distributed along the stem, at midsection mostly 8-40 cm wide.....*T. ohiensis*
7. Spathes markedly gibbous below and evenly puberulent throughout, abruptly narrowed into a linear extension; sepals

- predominantly glandular.....*T. gigantea*
7. Spathes not as described in the above, mostly leaf-like and gradually tapered; sepals predominantly eglandular-pubescent
8. Plants robust, mostly 40-80 cm high; midstem leaves mostly 1.5-4.0 cm wide.....*T. edwardsiana*
8. Plants not robust, mostly 20-40 cm high; midstem leaves mostly 0.8-1.5 cm wide.....*T. occidentalis*
- 9(1). Sepals mostly pubescent with a vestiture of long tawny eglandular hairs 2-3 mm long; roots uniformly slender, not fleshy or swollen, mostly 0.5-2.0 mm wide*T. hirsutiflora*
9. Sepals mostly pubescent with a vestiture of short glandular or non glandular hairs mostly 0.2-0.5 mm high and much longer glandular hairs 0.5-2.0 mm long, sometimes with only long hairs; roots to some extent fleshy or swollen, not uniformly fibrous, some or most of them 2-8 mm wide
10. Midstems with at least a few long tawny or silky-white appressed hairs or spreading glandular trichomes 1.5-2.5 mm long(11)
10. Midstems rather uniformly short pilose with glandular or eglandular trichomes 0.1-0.5 mm long(12)
11. Roots rather uniformly thick and fleshy and densely ferruginous-tomentose for 3-8 cm below the caudex; midstems densely white-pilose to tomentose.....*T. reverchonii*
11. Roots conical to obconical, fleshy and densely ferruginous-tomentose for 1-3(4) cm below the caudex, or else lignescent and elongate-obconical; midstems sparsely to moderately pilose, rarely tomentose.....*T. subacaulis*
12. Midstem leaves mostly 2-5 cm wide, widest well above the base; plants robust, 40-80 cm high.....*T. edwardsiana*
12. Midstem leaves mostly 0.5-2.0 cm wide, widest near the base; plants smaller, 10-40 cm high
13. Leaf surfaces glabrous or nearly so; granitic soils of central Texas (Llano, Burnett, and Blanco counties).....*T. pedicellata*
13. Leaf surfaces variously pubescent; not in granitic soils of Central Texas..... *T. humilis*

TRADESCANTIA BREVIFOLIA (Torr.) Rose, Contr. U.S. Natl. Herb. 3: 323.1895. Fig.1

Neotrelasea brevifolia (Torr.) Rose

Setcreasea brevifolia (Torr.) Pilger

Setcreasea ovata (Coul.) Faruqi, Celarier & Mehra

Treleasea brevifolia (Torr.) Rose

Treleasea leiandra var. *brevifolia* Torr.

Treleasea leiandra var. *ovata* Coul.

Hunt (1975) has discussed the nomenclatural history of this taxon in considerable detail, noting that the name *Setcreasea ovata* is not validated by the arguments mounted by Faruqi et al. (1959), who applied the name *S. brevifolia* to what Hunt (1975) and I call *S. buckleyi*. The latter is readily distinguished from *S. brevifolia* by its glabrous ovary (vs pubescent apically).

TRADESCANTIA BUCKLEYI (I.M. Johnst.) D. Hunt, Kew Bull. 30: 451. 1975. Fig. 2

Setcreasea brevifolia var. *buckleyi* (I.M. Johnst.) Faruqi & Mehra

Setcreasea brevifolia var. *nanella* Faruqi & Mehra

Setcreasea brevifolia var. *pulchella* Faruqi & Mehra

Setcreasea buckleyi I.M. Johnst.

Tradescantia speciosa S.B. Buckley, not *T. speciosa* L.

Hunt (1975) has discussed this taxon in detail, especially as relates to *T. brevifolia*, with which it has been confused. *Tradescantia buckleyi* is a relatively rare taxon, having been collected only a few times in Texas and closely adjacent northeastern Mexico.

Faruqi et al. (1970) described a dwarf form (from Gonzales Co.) as var. *nanella*; they also have given the name var. *pulchella* to forms from Hidalgo and Nueces Co., the latter from whence came the type of *T. buckleyi*.

TRADESCANTIA EDWARDSIANA Tharp, Rhodora 34: 57. 1932. Fig. 4

This robust, mostly glabrate-stemmed, broad-leaved species is superficially similar to *T. occidentalis* and *T. gigantea*, but is amply distinct as noted by several workers. Originally thought to be confined to southcentral Texas, recent acquisitions (TEX) have been made in Fannin and Lamar counties in northeastern Texas.

Most collections of this species have their midstems glabrous, but occasional plants have stems clearly pubescent (e.g. Bexar Co., *Carr 14572*, TEX), mostly in the manner of *T. humilis*.

TRADESCANTIA GIGANTEA Rose, Contr. U.S. Natl. Herb. 5: 205.1899. Fig. 5

This species is readily recognized by its robust habit and enlarged sheaths which are uniformly puberulent. It is most commonly found in central Texas, but sporadic populations occur eastwards as far as Louisiana, as noted by MacRoberts (1980). To judge from herbarium sheets, it occasionally hybridizes with both *T. occidentalis* (*Tharp 1256*, TEX) and *T. ohimensis* (*Hamric 7* TEX; *Jackson 1*, TEX), and probably yet other taxa with which it might co-occur.

TRADESCANTIA HIRSUTIFLORA Bush, Trans. Acad. Sci. St. Louis 14: 184. 1904. Fig. 6

Tradescantia australis Bush, type from Angelina Co., Tex.

Tradescantia tharpaii Anderson & Woodson [Texas material], type from Jasper Co., Arkansas

Anderson & Woodson (1935) stated that *T. hirsutiflora* (the type from Van Zandt Co., Texas) "is probably the most difficult and unsatisfactorily understood of the American representation of the genus." Apparently, they included in their concept of the species plants which I treat as belonging to yet other taxa, to judge from their description of the species. Indeed, they acknowledge the species to be "polymorphic" and with field study likely to be subdivided.

MacRoberts (1980a, 1980b) provides an excellent description and account of *T. hirsutiflora*, a common plant throughout much of east Texas, occurring mostly in sandy or sandy-loam soils. It is easily distinguished from most other species in Texas by its very slender fibrous roots, when dried ca 1 mm across, or less. MacRoberts (1980b) lists both *T. australis* and *T. eglandulosa* Bush (the type from Gillespie Co.) as synonymous with *T. hirsutiflora*, as did Anderson and Woodson (1935). However, I take the latter to be a synonym of *T. humilis*, *T. hirsutiflora* largely occurring to the east of the Edwards Plateau. My concept of *T. hirsutiflora*, at least in Texas, also contains elements of *T. tharpaii*, to judge by annotations of Anderson and Woodson on herbarium sheets at TEX.

TRADESCANTIA HUMILIS Rose, Contr. U.S. Natl. Herb. 5: 204.1899. Fig. 7

Tradescantia diffusa Bush, type from Bexar Co., Tex.

Tradescantia eglandulosa Bush, type from Gillespie Co., Tex.

Tradescantia intermedia Bush, type from Austin Co., Tex.

Tradescantia humilis, as conceived here, is a very variable species. Even within a given area numerous morphotypes are discernable, varying in habit (small or robust), sepal size, and degree of vestiture, etc. (cf. *Turner* 94-70, 94-79, 94-89, 94-91, TEX; all of these were collected ca 4 mi NW of Bellville in Austin Co.). It is possible that some or most of the variation mentioned in the forgoing is due to hybridization of *T. humilis*, past or present, with either *T. hirsutiflora* or *T. reverchonii*, if not both, for all three species are sympatric in the area concerned. In the vicinity of Houston, populations occur which have the habit and sepals of *T. hirsutiflora* but the stem pubescence of *T. humilis* (*Lundell* 11033, LL), and such plants occur sporadically southwards along the gulf coastal regions to Matagorda Co. (*Turner* 80-36A, TEX). I have annotated most of these as *T. humilis*, but they could be with equal validity called *T. hirsutiflora*, for even the fibrous roots of these collections are somewhat intermediate to the slender fascicled roots characteristic of *T. hirsutiflora*, and those of the elongate-tuberous type found in *T. humilis*.

TRADESCANTIA LEIANDRA Torr., Bot. Mex. Bound. Surv. 224. 1859. Fig. 8.

Neotreleasea leiandra (Torr.) Rose

Setcreasea leiandra (Torr.) Pilger

Setcreasea leiandra var. *glandulosa* Correll

Tradescantia leiandra var. *glandulosa* (Correll) Gandhi

This species is typified by material collected at Paisano Pass by Bigelow in 1854. Paisano Pass is located ca 12 mi east of Marfa in Presidio County. *Tradescantia leiandra* is a relatively uncommon species occurring mostly in igneous soils of the Trans-Pecos, usually in bluffs along seeps. Forms from the Chinati Mts of Presidio County (on ledges about Capote Falls) have glandular hairs; such plants have been called var. *glandulosa*, although both eglandular and glandular forms occur in the area concerned.

TRADESCANTIA OCCIDENTALIS (Britt.) Smyth., Trans. Kansas Acad. Sci. 16: 163. 1899. Fig.9.

Tradescantia occidentalis var. *melanthera* MacRoberts

Tradescantia occidentalis var. *scopulorum* (Rose) Anderson & Woodson

Tradescantia scopulorum Rose

Tradescantia vaginata Bush

Tradescantia virginiana var. *occidentalis* Britt.

This taxon superficially resembles *T. ohiensis* but is easily recognized by its markedly glandular-pubescent sepals. Populations from Trans-Pecos westwards to Arizona have nearly glabrous sepals, displaying only a smattering of glandular hairs, if that. These have been recognized as var. *scopulorum* by various authors and such plants may deserve nomenclatural recognition; at least most of the Trans-Pecos plants appear to be distinguishable from the more eastern var. *occidentalis*.

TRADESCANTIA OHIENSIS Raf., Prec. des Decouv. 45. 1814. Fig. 10

T. caniculata Raf.

T. difforme Bush

T. ohiensis var. *foliosa* (Small) MacRoberts

T. ohiensis var. *paludosa* (Anderson & Woodson) MacRoberts

T. paludosa Anderson & Woodson

T. reflexa Raf.

As noted by Correll and Johnston (1970), who adopted the spelling "ohoensis" for the taxon, *T. ohiensis* is a widespread relatively common species, occurring throughout the eastern U.S.A. where it is frequently cultivated. MacRoberts (1980) reports *T. ohiensis* to be the most commonly encountered *Tradescantia* in Louisiana, recognizing within it several varieties, as noted in the above synonymy, none of which appears to have geomorphological validity. To judge from his account and map showing their distribution in Louisiana, these would appear to be but individual or populational forms of a highly variable species, perhaps compounded by occasional hybridization, past or present, with

yet other species (e.g., *T. ohiensis* x *T. occidentalis*, Tharp 1256 [TEX], as annotated by MacRoberts).

TRADESCANTIA PEDICELLATA Celarier, Field & Laboratory 24: 6. 1956. Fig. 11

This is a weakly differentiated localized endemic of the Central Mineral Region of Texas where it is largely confined to granitic soils. *Tradescantia pedicellata* is a relatively small narrow-leaved plant having the root system of *T. subacaulis* (a fascicle of linear-oblongate tuberous roots, thickened distally), but the stems and elongate pedicels are sparsely to moderately glandular-pubescent.

MacRoberts (1978), incorrectly I think, took up the earlier name *T. diffusa* Bush for this taxon, the latter name typified by material from Bexar Co., Texas. MacRoberts, not being able to locate type material, inferring much from an inadequate description, assumed that *T. diffusa* was the same as *T. pedicellata*. Unfortunately, he selected as a neotype for the former, material collected in Burnet County (3 mi E of Buchanan Dam) that is certainly the same as Celarier's *T. pedicellata*; indeed, the latter individual was party to its collection (Gould, Brown & Celarier 5470, TAES). I believe that *T. diffusa* is synonymous with *T. humilis*; were the former in need of neotypification, material from Bexar County would have been a better choice. Of course, material referable to *T. pedicellata*, sensu Celarier, has not been collected in Bexar Co., or adjacent counties, to my knowledge. In the spring of 1996 I found *Tradescantia pedicellata* to be relatively common in granite stream-side deposits along ephemeral streams leading into the Llano River (specimens deposited TEX). It is a very distinctive taxon and worthy of recognition.

TRADESCANTIA REVERCHONII Bush, Trans. Acad. Sci. St. Louis 14: 190. 1904. Fig. 12

As noted by MacRoberts (1980b), "This is a distinctive species among *Tradescantia*, unlikely to be confused with any other if the roots are seen." The roots consist of fascicles of elongate, fleshy, densely pubescent tubers up to 10 cm long and 0.5-1.0 cm thick (including vestiture), thicker near the top than towards the base. This contrasts with the roots of the superficially similar *T. subacaulis*, which has a fibrous root system of slender non-tuberous roots.

Tradescantia reverchonii nearly always occurs in deep loose sandy soils and in habit is stiffly erect having thick stems and relatively few long, markedly hirsute, leaves. It is typified by material collected in Smith Co., Texas, and extends eastwards into Louisiana.

TRADESCANTIA SUBACaulis Bush, Trans. Acad. Sci. St. Louis 14: 185. 1904. Fig. 13

Tradescantia harbisonii Bush

Tradescantia texana Bush

This taxon is superficially similar to *T. hirsutiflora*, both possessing rather large sepals with long eglandular hairs. They are, however, readily distinguished by their roots, *T. hirsutiflora* having fascicles of slender unenlarged roots, *T. subacaulis* having fascicles of elongate-clavate tuberous roots. The sepals of the latter are usually to some extent glandular-pubescent, but in northcentral Texas forms and/or populations occur that lack glandular hairs. In the southern coastal regions of Texas populational forms occur having smaller sepals with shorter hairs, and more enlarged relatively fewer clavate roots, the latter often intermixed with slender non-succulent roots. The distribution of such plants is depicted in Fig. 10, and future field studies are likely to show that these are deserving of nomenclatural recognition.

In the sandy soils of southern Bexar, Medina and northern Atascosa counties, *T. subacaulis* varies in the direction of *T. reverchonii* (e.g., Johnston 3400, TEX), and populations in this region might be deserving of varietal, if not specific rank, for the roots are weakly developed versions of *T. reverchonii*, but the sepals are small and pubescent in the manner of coastal populations of *T. subacaulis*; the vestiture of the stems is somewhat inbetween that found in typical forms of these two species. Finally, it should be noted that Anderson and Woodson (1935) included elements of what I take to be *T. subacaulis* in their concept of a "polymorphic" *T. hirsutiflora*, to judge from annotations of these authors on material at TEX.

TRADESCANTIA WRIGHTII Rose & Bush, Trans. Acad. Sci. St. Louis 14: 188. 1904. Fig. 14

This taxon occurs on high ridges (2000-2600 m) of limestone scarps and mesas in the Trans-Pecos Texas, where it is relatively uncommon. It is represented by two varieties, a typical var. **wrightii**

(first collected by Wright in 1850 in the northern Trans-Pecos) which is glabrous throughout or nearly so, and var. **glandulopubescens** B.L. Turner (Phytologia 52: 370. 1983), of southern Brewster County and closely adjacent Mexico. Faden (pers. comm.), because the type of var. *wrightii* had few glandular hairs upon very close inspection, would not recognize var. *glandulopubescens*. The distinctions between these varieties are largely quantitative, the Big Bend and Mexican collections are very glandular pubescent, whilst the collections from elsewhere are essentially glabrous; since the character concerned is largely restricted to different geographic areas, I choose to recognize two morphogeographical elements, there being little intergradation between these.

UNCERTAIN SPECIES

TRADESCANTIA CRASSIFOLIA Cav., Icon. Pl. 1:54. 1791. Fig. 3

Faden (1993) makes a compelling case for the addition of this *Tradescantia* to the state's flora, noting that the first, and only known, collection of the species for Texas was reportedly made by V. Havard in October of 1880 from the Chinati Mountains of Trans-Pecos, Texas (Presidio Co.), presumably while serving as a Post Surgeon at Camp Eagle Nest in Presidio, Texas during the period Sep-Dec 1880. Nevertheless, in spite of numerous collection forays into the Chinati Mountains since that time by many workers (A.M. Powell, SRSC; Emily Lott et al., TEX; etc.), the species has not been recollected. While Faden contends that there is little evidence that Havard ever collected in Mexico, it is still possible that *T. crassifolia* was obtained by him in northern Mexico along the Rio Grande, perhaps in the high mountains along the border regions not too distant from Presidio, such specimens subsequently inadvertently mixed with his, undoubtedly, Chinati collections. It is noteworthy, that *Tradescantia crassifolia* is not listed among the 34 flowering herbs listed as occurring in the Chinati [Chenete] Mts. by Havard in his report of 1885 (Proc. U.S. Natl. Mus. 8: 492-493). Because of the uncertainty of the Havard collection, this species is not keyed in the present treatment, although its reported collection site is shown in Fig. 3. The species, however, might ultimately be found in this or that mountain range along the Trans-Pecos side of the Rio Grande.

ACKNOWLEDGEMENTS

I am grateful to Dr. R.B. Faden for providing me with an advanced version of his treatment of *Tradescantia* for the flora of North America, this after the account here was written, copy of which was provided him. The only significant conflict perceived by me in our two independent treatments is that I do not believe that *T. crassifolia* is documented with certainty as occurring in Texas. The distributional maps (Fig. 1-14) are based upon specimens housed at LL, SRSC, and TEX.

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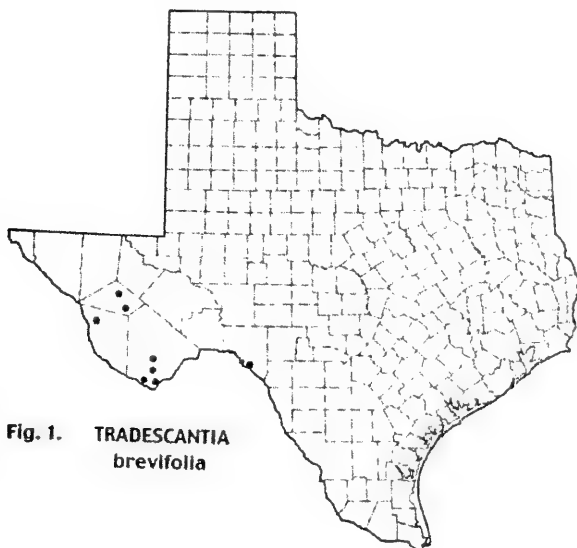


Fig. 1. *TRADESCANTIA*
brevifolia

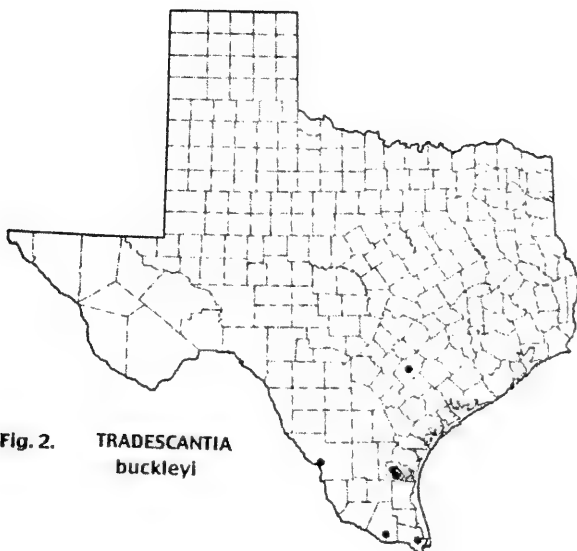


Fig. 2. *TRADESCANTIA*
buckleyi

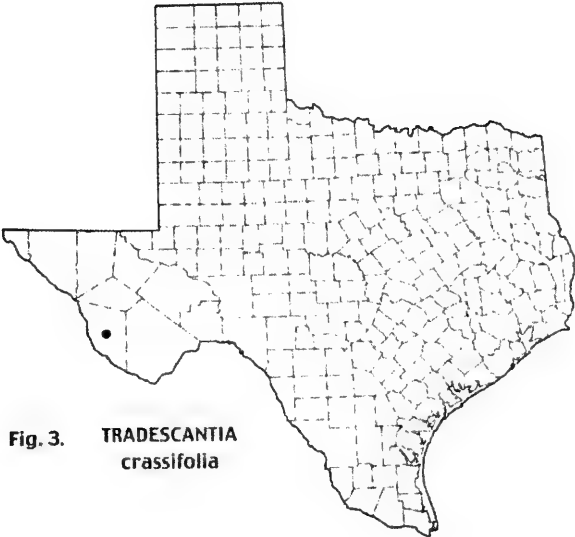


Fig. 3. *TRADESCANTIA*
crassifolia

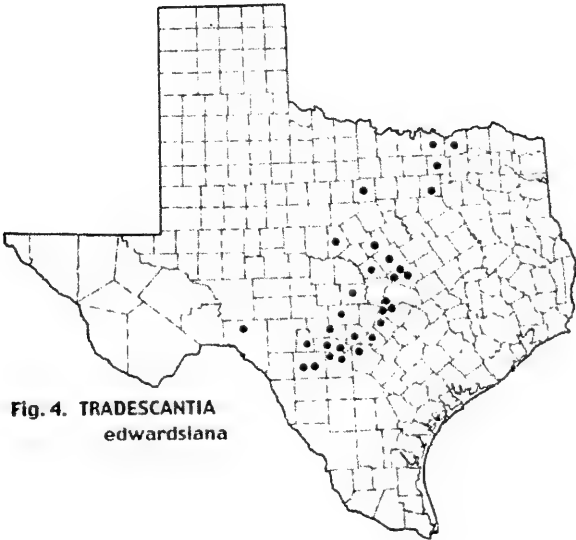
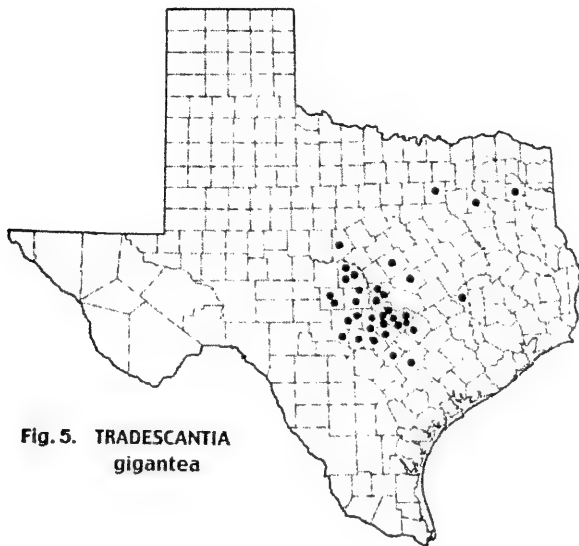
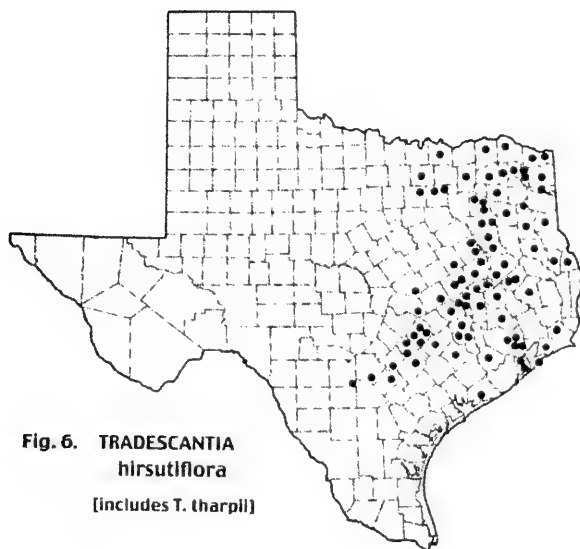


Fig. 4. *TRADESCANTIA*
edwardsiana



**Fig. 5. *TRADESCANTIA*
*gigantea***



**Fig. 6. *TRADESCANTIA*
hirsutiflora
[includes *T. tharpii*]**

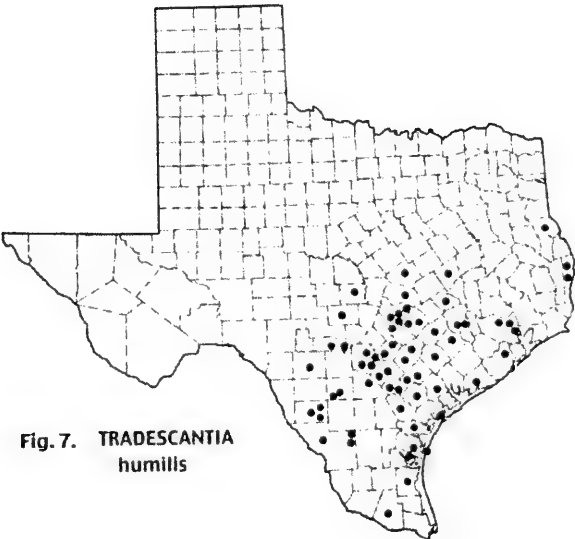


Fig. 7. *TRADESCANTIA*
humilis

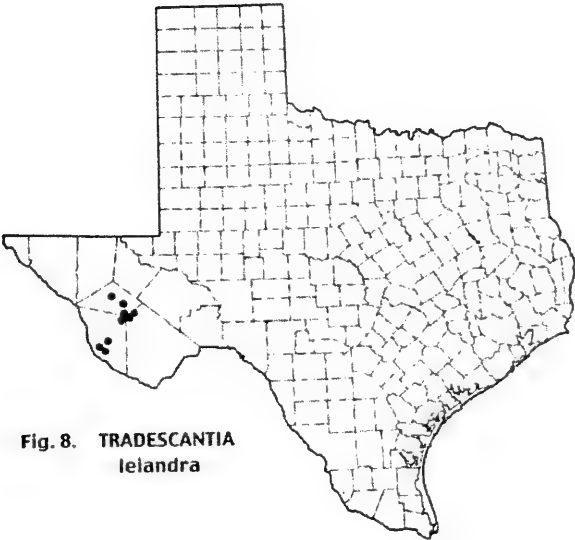


Fig. 8. *TRADESCANTIA*
lelandra

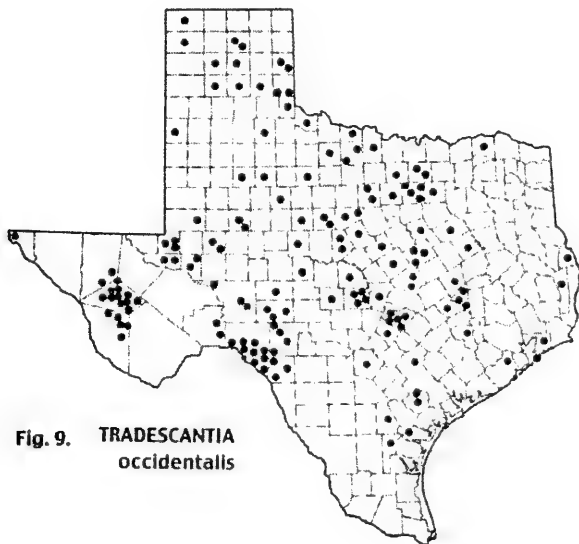


Fig. 9. *TRADESCANTIA*
occidentalis

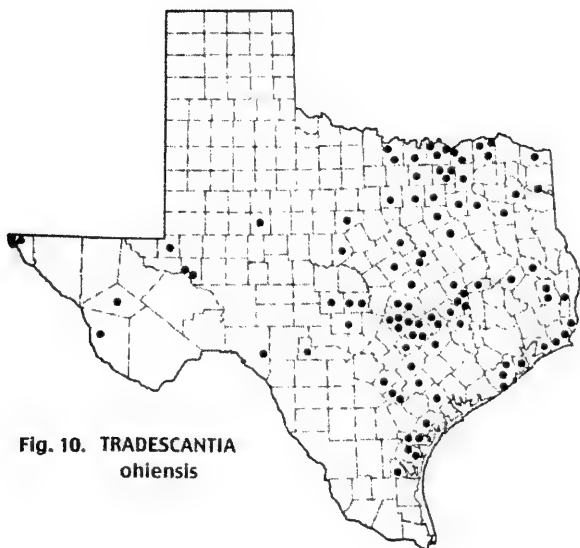
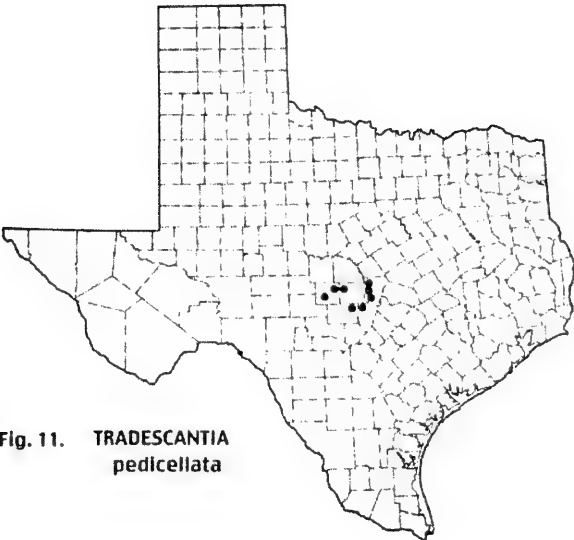
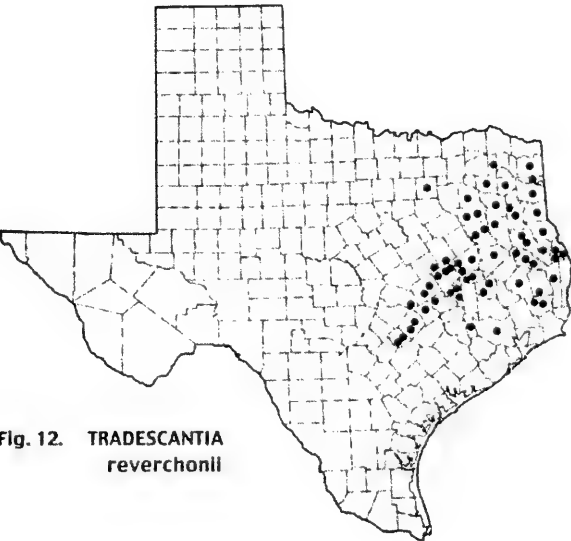


Fig. 10. *TRADESCANTIA*
ohiensis



**Fig. 11. TRADESCANTIA
pedicellata**



**Fig. 12. TRADESCANTIA
reverchonii**

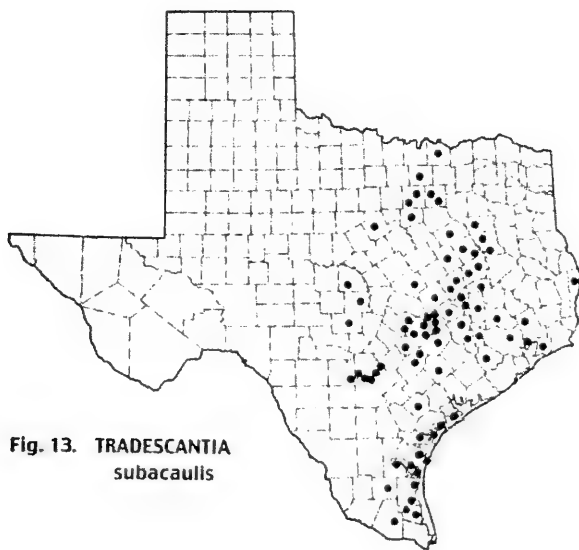


Fig. 13. *TRADESCANTIA*
subacaulis

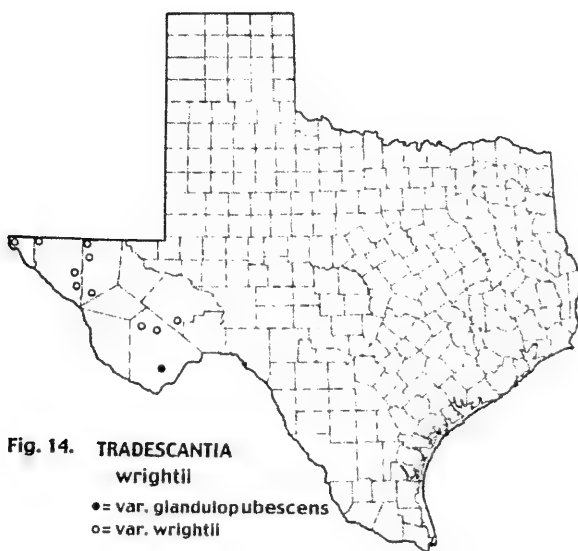


Fig. 14. *TRADESCANTIA*
wrightii
● = *var. glandulopubescens*
○ = *var. wrightii*

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